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Bridging the Gap: A Design-based Case Study of a Mathematics Skills Intervention Program

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Education

in

Educational Leadership

by

Leila Safaralian

Committee in charge:

California State University, San Marcos

Kenneth P. Gonzalez, Chair

Manuel Vargas

University of California, San Diego

Carolyn Huie Hofstetter

2017

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The Dissertation of Leila Safaralian is approved, and is acceptable in quality and form for publication on microfilm and electronically:

Chair

University of California, San Diego

California State University San Marcos

2017

Dedication

I dedicate this dissertation to my incredible, encouraging, and supportive family.

To my beautiful children, Arman and Melina for being supportive and patient;

To my wonderful husband for taking care of our kids when I was absent;

To my dad who was with me in spirit every step of the way;

To my mom who always encouraged me to keep going;

So that I could finish my doctoral journey.

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Vita

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2015-2017	Co-chair of Achieving the Dream initiative, MiraCosta College

Abstract of the Dissertation

Bridge the Gap: A Design-based Case Study of a Mathematics Skills Intervention Program

by

Leila Safaralian

Doctor of Education in Educational Leadership

University of California, San Diego, 2017
California State University, San Marcos, 2017

Kenneth P. Gonzalez, Chair

Many students aspire to continue their educational journey, but far too many enter college without the basic content knowledge, skills, or habits of mind needed to succeed. Research on college readiness indicates the significant role mathematics achievement plays in attaining a college degree and advancing professionally. This dissertation study provides a broad examination of college readiness in mathematics among entering college students. Specifically, in an effort to improve access to college-level mathematics

courses for underrepresented students, it examines the meaning and significance of an existing program to help students transition to college.

The Mathematics Success program at Oceanview Community College provides enrichment instruction in mathematics for the purpose of improving placement test scores and enabling students to take a shorter path to transfer-level mathematics courses. This qualitative study utilized design-based case study methodology to investigate whether the Mathematics Success program was effective in helping students improve their mathematics placement scores and, if so, why this might occur. The researcher found that classroom tutors, tutoring services, supplemental practices, and the Math Anxiety workshop were the most valuable aspects of the program to help students succeed in the mathematics placement test. The quantitative results of this study showed that there is no relation between the time since the last mathematics class and students' scores on the post-test. Also, there was a strong positive relationship between the post-assessment scores and pre-assessment results. Implications for social justice and leadership in higher education institutions are also discussed.

Chapter One: Introduction

Statement of the Problem

Evidence of deficiencies in reading comprehension, writing skills, and mathematics competency among entering college students has been documented nationwide (Callan, Finney, Kirst, Usdan, & Venezia, 2006; Sablan, 2014; Venezia & Jaeger, 2013). This is especially true among community colleges, which enroll about 44% of undergraduate students and have an open access policy that admits any student over the age of 18 who applies (Callan, Finney, Kirst, Usdan, & Venezia, 2006). For example, about 30% of entering college students are assessed as deficient in reading comprehension and writing and 60% are identified as deficient in mathematics (Bailey, Jeong & Cho, 2010).

In response to such concerns, community colleges have designed a developmental curriculum, also called developmental education, and in California, Basic Skills. For the purpose of this paper, the researcher will use the term "developmental education" to signify courses that provide instruction for entering college students who are assessed as being academically underprepared for college-level courses. Such curricula were designed to remediate deficiencies in reading, writing and mathematics with the assumption that enhancing such skills would ensure successful college completion. After more than three decades of implementation of such curricula, college completion rates remain alarmingly low. Unfortunately, only one third of community college students successfully complete their educational goals in six years (Goldrick-Rab, 2010; Li et al., 2012, Sablan, 2014). In fact, many now argue that low college completion rates are due

to students being placed in developmental education curricula, given that most students who begin their college studies in developmental education never reach and complete college-level English or mathematics courses (Byrd & MacDonald, 2005; Kirst, 2008; Ngo & Melguizo, 2015; Prather & Bos, 2014). Nationwide, only 30% of students referred to developmental mathematics and 44% referred to developmental reading complete their sequences within three years (Bailey, Jeong & Cho, 2010).

Research suggests that of the three developmental subjects that impede college completion, mathematics is by far the most prominent. Nationally, between 40% and 60% of entering community college students are assessed into developmental mathematics courses (Goldrick-Rab, 2010; Li et al., 2012, Sablan, 2014). More specifically, 24% of these students are placed into one level below college-level, 16% to two levels below college-level, and 19% to three or more levels below college-level mathematics (Bailey, Jeong, & Cho, 2010). In most colleges, entering students are assigned to different levels of developmental education on the basis of performance on placement tests. Students with greater academic deficiencies are often referred to a sequence of two, or more, courses designed to prepare them for the first college-level mathematics course. For example, those with the greatest need for developmental mathematics are referred to arithmetic, basic algebra, and intermediate algebra in order to prepare them for college-level algebra (Bailey, Jeong, & Cho, 2010). Additionally, students placed into the lowest level of the developmental mathematics have a college-level mathematics completion rate in the single digits (Byrd & MacDonald, 2005; Kirst, 2008; Ngo & Melguizo, 2015; Prather & Bos, 2014). Not surprisingly, mathematics is commonly identified as an obstacle in successfully completing college.

One of the greatest challenges that community colleges face is improving the success of students in their developmental education programs (Rutschow & Schneider, 2011). To address this problem, colleges have designed and implemented various programs and support services to improve student success in college, specifically in mathematics. Academic enrichment and intervention programs have become common strategies to help underprepared students. Although these programs vary in terms of scope, sponsorship, and implementation, they seek to address the academic and skill deficits. The most common programs that have been instituted nationwide by many higher education institutions are summer bridge programs (Wathington, Pretlow, & Barnett, 2016). These are supplemental programs, aimed to enhance students' academic content knowledge and other cognitive and non-cognitive skills needed for academic success, such as study skills, time management, and social adjustment (Rutschow & Schneider, 2011). While all summer bridge programs differ in their components and implementations, three features are commonly present: a) helping entering college students with the academic transition to college, b) preparing students for college socially and financially before fall semester, and c) familiarizing first-year students with the student support services like tutoring and mentoring resources (Cabrera, Miner, & Milem, 2013; Ghazzawi & Jagannathan, 2010; Murphy, Gaughan, Hume, & Moore, 2010; Reisel, Jablonski, Hosseini, & Munson, 2012).

Summer bridge programs' participants are usually underrepresented students, including first-generation, minority, low income, and students who were placed in developmental courses (Sablan, 2014). Many researchers (Cabrera, Miner, & Milem, 2013; Ghazzawi & Jagannathan, 2010; Murphy, Gaughan, Hume, & Moore, 2010;

Raines, 2012; Russomanno et al., 2010; Stephens, Hamedani, & Destin, 2014; St. John et al., 2014; Sablan, 2014) conclude that summer bridge programs are one of the best remedies to increase college readiness among underrepresented students.

Furthermore, summer bridge programs have positive impacts on the participants' performance in college placement tests, first year GPA, retention, persistence, graduation rate, and overall college academic performance (Cabrera, Miner, & Milem, 2013; Ghazzawi & Jagannathan, 2010; Murphy, Gaughan, Hume, & Moore, 2010; Raines, 2012; Reisel, Jablonski, Hosseini, & Munson, 2012; Russomanno et al., 2010; Stephens, Hamedani, & Destin, 2014; St. John et al., 2014; Sablan, 2014). Research also indicates summer bridge programs help low-income, first generation, and minority students successfully transition to college; but they are usually among the first programs to get cut when resources are limited (Cabrera et al., 2013; Stephens, Hamedani, & Destin, 2014).

Another approach to address the lack of mathematics competency among entering college students includes offering a mathematics placement test preparation program. Several studies measured the effectiveness of refresher programs on mathematics placement test scores of entering college students, and most revealed positive results (Cabrera, Miner, & Milem, 2013; Murphy, Gaughan, Hume, & Moore, 2010; Raines, 2012; Reisel, Jablonski, Hosseini, & Munson, 2012). For example, researchers employed quantitative data to examine the effects of a refresher program for entering engineering and computer science students at the University of Wisconsin-Milwaukee from 2007 to 2010 (Reisel, Jablonski, Hosseini, & Munson, 2012). This program was offered for six weeks to students who were placed in a course lower than Calculus. The result indicated that the students in the program improved their mathematics placement test (Reisel,

Jablonski, Hosseini, & Munson, 2012). Even though this program has shown some success, the cost of offering a six-week program has raised concerns given an unstable budgetary environment. In recent years, deep state funding cuts have had major consequences for public colleges and universities. When state funding is cut, colleges are forced to make up the difference by increasing tuition levels, cuts to educational programs, and other students services (Mitchell & Leachman, 2015). Thus, the length of time is important to sustain an effective program in an uncertain budgetary environment.

Similarly, Intensive Math Program (IMP) at California State University, San Bernardino (CSUSB) was offered to enhance students' academic content knowledge as well as non-cognitive skills needed for academic success such as study skills, time management, and social adjustment (Rutschow & Schneider, 2011). IMP, created in 2001, allows participants who require one or two developmental mathematics courses the opportunity to finish their developmental requirements prior to their first semester by completing the five-week summer bridge program. Most recently, over 90% of the 755 students who participated in the summer 2015 program successfully tested out of developmental mathematics after the completion of the bridge program (Jones & Assalone, 2016). Even though this program showed positive results for the participants' success on the mathematics placement test, it was offered for five weeks in summer using a software package as a primary teaching tool. Students were sitting in front of the computer every day for five weeks trying to learn the mathematical concepts on their own with little assistance from instructor or tutors. Recent research has shown that using mathematics software as a primary tool of teaching decreases students' success rate (Wong, 2013).

Another offering is the University of Arizona New Start Summer Program for underrepresented college students including low-income, racial minority, and first generation. This program has shown positive impact on the participants' first year GPA and retention. The New Start Summer Program is designed for students to develop study skills, utilize support services such as tutoring and the library, while practicing college course work. The results of the quantitative data indicate that the New Start Summer program positively impacted academic performance and persistence of the participants. The shortcoming of these types of evaluations are that they do not utilize a comparison group or track students for a long period of time, and they use descriptive analyses of their surveys instead of quantitative data. Even though this program helped a successful transition to college for low-income, first generation, and minority students, it did not specifically prepare the participants for the mathematics placement test. The students participated in the program for six weeks to learn about study skills that they need to be successful in college coursework and support services such as tutoring (Cabrera, Miner, & Milem, 2013).

Over the last decade, some colleges have designed and implemented refresher programs to help students improve their placement scores. Some colleges have posted statements in their websites warning students about the consequences of poor performance in the placement tests. They also inform students that preparing well for placement test can save them both time and money, and that it will help them achieve their educational goals faster. Additionally, some colleges have posted practice placement test questions on their websites that usually include between 16 to 20 questions without any guidance on how to solve the problems correctly. In 2006, El Paso Community

College implemented some intervention activities to prepare the entering college students for the placement tests. Preparation and intervention activities may strive to strengthen placement test orientation, increase student participation in pre-testing, offer appropriate post-testing interventions, incorporate placement test skill requirements into high school curriculum, and provide practice tests (Brown, 2006). The shortcoming of these types of activities is that they are not directly targeting the mathematics placement test in a short period of time, and they mostly provide general information about placement tests.

Higher education institutions have long utilized summer bridge programs to improve the college success of students; however, the research on their effectiveness is limited (Wathington, Pretlow & Barnett, 2016). Most of the studies show that summer bridge programs last from four to six weeks and are costly and difficult to sustain. Furthermore, there are three primary sources of funding for these programs: federal and state, institutional, and foundation funds. For example, in Texas community colleges, the cost of attending summer bridge program is about $1300 per student (Sablan, 2014). In recent years, extreme state funding cuts caused major problems and concerns for public colleges and universities. These cuts led to excessive tuition increases that placed colleges out of reach for many students. These cuts also raised concerns about weakening the quality of education at a time when a highly educated workforce is needed for the nation's economic future (Mitchell & Leachman, 2015; Sablan, 2014). Even though, as states restore some funding that was cut in recent years, their support for higher education remains well below pre-recession levels, which decreases college affordability, especially for low socioeconomic and underrepresented students (Mitchell & Leachman, 2015). Thus, it is significant to consider the source of the funding and the

cost of the program as the administrators seek to justify cost-effectiveness and outcome effectiveness of programs for helping students with college readiness and transition (Sablan, 2014). In reality, sustaining a six-week program in an unstable economic budgetary environment would be extremely challenging.

Furthermore, most of the existing research about summer bridge programs is related to student retention, college GPA, self-efficacy, and social skills. There is a major gap in studying intensive review programs that directly target mathematics placement test scores among students who are placed in developmental mathematics. Additionally, there is little or no information about the design and the implementation of these programs; thus, they cannot effectively inform the practitioner community.

Purpose of the Study

At Oceanview Community College, where this study was conducted, about 77% of entering college students are placed into developmental mathematics courses; the majority of these students come from already vulnerable populations. This site incorporates a fictional name to protect confidentiality. Oceanview Community College's statistics regarding developmental coursework mirrors the national trends on developmental coursework and college readiness making it a representative site for inquiry.

At Oceanview Community College, the Mathematics Success program, a refresher developmental mathematics program, implemented in summer of 2014, is designed to improve student achievement in mathematics. The Mathematic Success program provides enrichment instruction in mathematics for students admitted to any program at the college for the purpose of improving placement test scores and enabling

students to take a shorter path to transfer-level mathematics courses. Participants attend an intensive review program for four hours per day, for seven days, that includes two hours of instruction, directly taught by a mathematics faculty member, and two hours of review with an instructional aide to review the material learned in the first two hours. The curriculum for this program was designed based on the topics covered in the mathematics placement test. Students who successfully complete the program are able to retake the mathematics placement test to improve their scores so that they may enroll in a higher-level mathematics class and reduce their time-to-degree completion.

The measure for success in the Mathematics Success program is based on the improvement in placement test scores that are used to place entering college students. All participants take the mathematics placement test before starting the program and again after program completion. This is mandatory because it helps determine an appropriate level that students should be placed in the program. Also, results are used as benchmarks to see how much students improve after attending the program. Throughout the three years that this program has been in practice, 95% of participating students proceed to place in a higher mathematics class after attending the program and taking the mathematics placement test.

This study focuses on the Mathematics Success program and implements a design-based case study approach. A case study approach is used to describe and evaluate an intervention, or phenomenon, and the real-life context in which it occurs (Cobb, Jackson, & Dunlap, 2014; Baxter & Jack, 2008). Design-based research (DBR) is used to study learning in environments that are designed and systematically changed by the researcher (Sawyer, 2005). At this time, the current research on placement tests

preparation programs is inadequate to either inform the practitioner community or provide insight to design an efficient and sustainable refresher program. Thus, the researcher has chosen a design-based case study for the purpose of informing practitioner-based community in a way that will allow for the design of an effective program.

It is important to note that most programs in higher education take place as part of larger organizational change. This is also true for the Mathematics Success program at Oceanview Community College. Since the summer of 2014 when the Mathematics Success program was implemented for the first time, two major changes have taken place at Oceanview Community College: the Multiple Measures Assessment (MMA) and the Common Assessment Initiative (CAI). MMA refers to the use of more than one indicator of college readiness to place entering students into college-level coursework. The most commonly used multiple measures are a combination of high school grade point average (GPA) and standardized placement tests (Dadgar, Collins, & Schaefer, 2015; Scott-Clayton, Crosta & Belfield, 2014). Furthermore, based on California Assembly Bill 743, all California community colleges are required to develop a common English and mathematics assessment system. The Common Assessment System provides colleges with effective and valid English, English as a Second Language, and mathematics assessment instruments; a reliable testing platform; student test preparation resources; college research guidance; and professional development (Prather & Bos, 2014).

In February 2016, Oceanview Community College Mathematics Department began to use the MMA for assessing entering college students. As a result, ten categories were formed to use as guidance tools for placing students. After implementing the MMA,

more entering college students were placed into college-level mathematics courses. The students who do not meet the high school GPA or prior mathematics course will be placed into developmental courses. These students may choose to attend the Mathematics Success program to get adequate preparation for taking the mathematics placement test and potentially be placed in a higher-level mathematics course. Consequently, since these students do not have the required GPA or did not take the required mathematics class in high school, they may have lower mathematical skills and need more practice to understand the mathematical concepts. Thus, this may affect the Mathematics Success program's design to address the new populations' needs.

Another change that is important to note includes the Common Assessment Initiative. The Common Assessment Initiative has not yet been implemented at Oceanview Community College. The CAI is currently under development with plans to launch the new instrument in 2017. Since faculty at the Oceanview Community College are aware of this impending change, conversations around assessment and placement have been happening more frequently and with more urgency. The CAI may affect the Mathematics Success programs' future curriculum and design.

Research Questions

Although the Mathematics Success program offers promise as an intervention to help students succeed in mathematics placement test, a rigorous examination of its effectiveness is needed. The primary aim of this study is to examine the effectiveness of the Mathematics Success program in helping entering college students who are placed in developmental mathematics courses. Based on placement test scores, students who decide to attend the Mathematics Success program are assigned to one of three courses: Pre-

algebra (Mathematics 20), Elementary Algebra (Mathematics 30), or Intermediate Algebra (Mathematics 64). After attending the program for four hours over seven days, for a total of 28 hours, they retake the mathematics placement test and are potentially placed in a higher mathematics class, saving time and money.

Through this qualitative study, the researcher investigated the implementation and outcomes of the Mathematics Success program to understand better whether students improve academically after completing this seven-day program and, if so, arrive at possible explanations. This study addresses the following research questions:

1. From students' point of view, what aspects of the program were most helpful in increasing their placement test level?
2. From students' point of view, what aspects of the program should be changed to make the program more effective?
3. From program instructional staff's point of view, what aspects of the program have the most impact on students' ability to increase their placement level?
4. From program instructional staff's point of view, what aspects of the program should be changed to make the program more effective?
5. Is there a change in placement test scores between pre-test scores (T1) and post-test scores (T2) after attending the program?

How much of the variance in the change in the students' scores on the placement test can be explained by gender, ethnicity, and previous mathematical skills?

Research Methodology

This research examines the Mathematics Success program through a design-based case study, which is used to describe and evaluate an intervention or phenomenon and the

real-life context in which it occurs (Cobb, Jackson, & Dunlap, 2014; Baxter & Jack, 2008). DBR is a fluid and pragmatic methodology that accounts for potential shifts and enables adaptation. By analyzing this program within a naturalist context, classroom practices remain at the forefront of shaping this study (Reimann, 2011; Sawyer, 2005). To supplement the qualitative data, quantitative data were used as a background for description and understanding of the specific case. The results were analyzed to find the factors, which contributed to the improvement of the Mathematics Success program. See Appendices D and E for a list of the interview questions.

Participants, Procedures, & Data Collection. In the study of the Mathematics Success program, the participants consisted of the person in charge of the program, faculty, instructional aides, staff, and the students. All of the participants had a voice in this study. All participants were interviewed in addition to completing an online survey using Qualtircs.com. The survey questions were very similar to the interview questions and the participants could answer freely without the presence of the person in charge of the program. The interviews were semi-structured and lasted approximately 10 to 30 minutes in length. It was expected that the participatory evaluator and the participants reported on their true experiences in order to inform a deep understanding of the design and implementation elements of the Mathematics Success program. To understand the core issue of this study, the researcher used purposive sampling and interviewed ten current students, five former students, and nine program instructional staff associated with the Mathematics Success program. The quantitative data included the pre-test and post-test scores of the mathematics placement test of the participants. Moreover, the information about gender, ethnicity, level of education, last mathematics class taken, and

years since the last mathematics class were collected from the participants before starting the program.

Organization of the Dissertation

The first chapter of this dissertation offers background on deficiencies in reading comprehension, writing skills, and mathematics competency of entering college students, developmental education and their effects on college completion rates, summer bridge programs and their components and implementations, as well as their positive impact on the participants' performance in college placement tests, first year GPA, retention, persistence, graduation rate, and overall college academic performance. Furthermore, the limited research on refresher programs is presented. Chapter two is comprised of a review of the existing literature, which focuses on the lack of college readiness of entering college students, academic and non-academic factors influencing college readiness, placement process and policies, as well as college remediation and intervention programs and support for underrepresented students. Chapter three presents a detailed description of the design-based case study of the Mathematics Success program. This chapter includes the methodology of this study including participant selection, interview process and questions, and data collection. Chapter four presents quantitative and qualitative data related to the research questions for the study of Mathematics Success program at Oceanview Community College by offering details of the study through surveys and individual interviews. Chapter five discusses the implications for the findings.

Chapter Two: Literature Review

Introduction

College readiness for high school students is a high priority across the U.S. education system. Many national and state policies, initiatives, and reforms are focused on students' college readiness at the high school and college levels (Hodara & Cox, 2016). Without adequate reading comprehension, writing skills, and mathematics competency, students will not be successful in higher education. Community colleges enroll about 44% of undergraduate students and these institutions have an open access policy, which allows any student over the age of 18 to matriculate (Callan, Finney, Kirst, Usdan, & Venezia, 2006). However, only approximately one third of college students successfully attain their educational goals within a six-year period (Goldrick-Rab, 2010; Li et al., 2012).

More than half of entering college students in the United States are placed into developmental courses. College remediation includes intervention programs such as mathematics developmental courses and psychosocial and behavioral supports (Callan, Finney, Kirst, Usdan, & Venezia, 2006; Venezia & Jaeger, 2013). For the purpose of this study the researcher will use "developmental courses" to signify the courses that provide instruction and support for entering college students who are assessed as being academically underprepared for college-level courses.

College readiness is the level of preparation that students need to enroll and succeed in a college program without taking developmental courses (Li et al., 2012; Venezia & Jaeger, 2013). Nationwide, a large number of entering college students require

remediation. Between 40% and 60% of entering college students—a majority of whom are first generation, low-income, and students of color—are placed in at least one developmental course in mathematics or English (Byrd & MacDonald, 2005; Goldrick-Rab, 2010; Li et al., 2012; Venezia & Jaeger, 2013). Additionally, providing developmental education for entering college students requires a significant amount of state funding (Martorell & McFarlin, 2011; Melguizo, Kosiewicz, Prather, & Bos, 2014; Long, Iatarola & Conger, 2009). Thus, many educators primarily focus on the level of college readiness among underrepresented high school students and the effectiveness of existing programs to help transition to college (Venezia & Jaeger, 2013; Tierney & Sablan 2013).

Colleges mostly place students in developmental courses based on performance on the Scholastic Assessment Test (SAT) or American College Testing (ACT), usually taken in high school, or the ACCUPLACER or ACT Compass, taken as needed during matriculation (Fields & Parsad, 2012). ACCUPLACER and ACT Compass are exams taken by students entering a higher education institution to determine which level of courses they should be placed in. These exams are usually taken by students who did not take the SAT or ACT, who scored below the cut-scores on the SAT and ACT for placement in college-level courses, or who are entering college several years after leaving high school. Many higher educational institutions are eliminating the ACT Compass exam. Recent research suggests that reliance on these test-based measures may misdirect some students to developmental coursework when they could have succeeded in college coursework. Similarly, relying on test-based measures also sends some students to

college-level coursework when they could have benefited from developmental coursework (Scott-Clayton, Crosta, & Belfield, 2014).

To improve the placement process and assign students to the highest level of coursework in which they are likely to succeed, colleges are beginning to use high school grades or high school grade point average in addition to test scores (Bracco et al., 2014; Dadgar, Collins, & Schaefer, 2015; Scott-Clayton, 2014). High school grade point average may be useful because it is not just a measure of cognitive ability; instead, it is a cumulative measure of academic achievement in multiple subjects across a student's high school career and thus may signal a broader range of skills related to college readiness, such as a student's academic tenacity and motivation (Bowen et al., 2009).

Lack of college readiness has academic and non-academic roots. Some academic factors may include misalignments between high school curriculum and college requirements, and differences in the quality of education provided to underrepresented students (Venezia & Jaeger, 2013). For example, in 2007-2008 only 28% of high school graduates from high-poverty areas attended a four-year university in which a majority of them were placed into at least one developmental course. Moreover, students who take advanced mathematics courses in high school are more likely to be college ready (Venezia & Jaeger, 2013). A deep understanding of mathematics develops analytical skills, critical thinking, and data interpretation. However, Hispanic, African-American—often first-generation college students—have disproportionately low rates of representation in advanced mathematics classes (Long, Iatarola, & Conger, 2009; Maxwell et al., 2003; Mulvey, 2009; Riegle-Crumb & Grodsky, 2010). In this dissertation the researcher uses Hispanic and Latino interchangeably and both refer to a

person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race, and states that Hispanics or Latinos can be of any race, any ancestry, any ethnicity (Passel & Taylor, 2009.) Some non-academic factors include peer influences outside the school, parental expectations, time management, goal focus, self-advocacy, and lack of social capital (Barnes and Slate, 2014; Venezia & Jaeger, 2013; Yamamura, Martinez, & Saenz, 2010).

According to national math proficiency studies, American high school graduates do not demonstrate mathematical proficiency to take college-level mathematics courses (Byrd & MacDonald, 2005; Corbishley & Truxaw, 2010; Strayhorn, 2013; Venezia & Jaeger, 2013). Mathematics college readiness is a student's ability to be successful in college-level mathematics courses without the need for developmental coursework (Conley, 2007; McCormick & Lucas, 2011). It plays an important role in students' admission to college and attainment of a college degree (Aughinbaugh, 2012; McCormick & Lucas, 2011). The National Council of Teachers of Mathematics has articulated impressive goals for preparing students for college-level mathematics, as well as for the workforce (Corbishley & Truxaw, 2010). However, despite 30 years of national and state educational legislation mandating more rigorous courses, testing, and accountability, little has improved; college-readiness rates are low, student drop-out rates are high, and the achievement gap is wide (Barnes & Slate, 2014).

To combat this national issue, many colleges have initiated developmental programs designed to bridge the gap between high school and college. Such programs have been widely researched and have provided assistance to entering college students to increase college readiness and enable students to take a shorter path to college-level

courses. Interventions to improve college readiness offer a variety of services including academic preparation, dual enrollment, early assessment, summer bridge programs, study skills courses, boot camps, and brush-ups. Most of these programs take place in summer before starting the first semester in college. Over the past decades, many scholars have researched the effectiveness of college developmental education for improving student success (Cabrera, Miner, & Milem, 2013; Howell, 2011; Wong, 2013; Murphy, Gaughan, Hume, & Moore, 2010). With appropriate assistance and guidance, underprepared students including first-generation, low-income, and students of color, can have a successful college experience (Combs, Slate, Moore, Bustamante, Onwuegbuzie, & Edmonson, 2010; Ghazzawi & Jagannathan, 2010; Venezia & Jaeger, 2013; Yamamura, Martinez, & Saenz, 2010).

This literature review examines the lack of college readiness among underrepresented entering college students and examines studies on college remediation that seek to improve mathematics skills and success of these students. In addition, literature about college assessment and placement policies will be reviewed. While the interventions and reforms appear promising, there is a need for more research, specifically of mathematics placement intervention programs, to improve students' scores on the assessment entrance exam. These programs will assist entering college students to take a shorter path to college-level mathematics courses.

Review of the Literature

College Readiness. College readiness represents a student's ability to demonstrate skills, knowledge, and study habits to be successful in college-level courses (Conley & French, 2014; McCormick & Lucas, 2011; Strayhorn, 2013; Venezia &

Jaeger, 2013). According to the U.S. Department of Education, college readiness is a national educational priority and is an important issue to high school teachers, parents, students, employers, and government officials (McCormick & Lucas, 2011). President Barack Obama, in a recent meeting of the nation's governors, emphasized the value in college readiness programs. He indicated that his administration has invested more than $100 million in a College Pathways program geared to ensure that high school graduates are college and career-ready. At the same time, former Secretary of Education Margaret Spellings' Commission on Higher Education noted the significance of higher education in contributing towards homeland security, global competitiveness, and innovation. She also acknowledged numerous shortcomings of current educational pathways and the need for an increased accountability in college readiness on the part of high schools (Strayhorn, 2013). Despite this national attention, data suggest that, overall, recent high school graduates are not college ready. For instance, out of 1.5 million high school graduates who took the American College Testing (ACT) in 2009, only 23% of them were ready to enroll in college-level courses without remediation (Foote, Schulkind, & Shapiro, 2015; Strayhorn, 2013).

Despite many attempts to improve college readiness among entering college students, 41% of entering community college students and 29% of all entering four-year university students are underprepared in at least one of the basic skills of reading, writing, and mathematics (Byrd & MacDonald, 2005; Goldrick-Rab, 2010; Kowski, 2013; Li et al., 2012; Mulvey, 2009; Venezia & Jaeger, 2013). The majority of these students are first generation, returning adults, military veterans, disabled, and minority students. Students who take developmental courses may spend two extra years in college, thus

affecting the time for degree attainment. Consequently, having their degree time extended delays the graduation, increases their financial burden, and puts more pressure on institutes of higher education to provide services for these students (Byrd & MacDonald, 2005).

While the increase in developmental courses and programs at community colleges show that the lack of college readiness is growing, it is not a new phenomenon (Byrd & MacDonald, 2005). One of the reasons for the lack of college readiness is that community colleges have always had an open access policy, and admit any student over the age of 18. As access to higher education increases, so does the number of students placed into developmental courses. After students are admitted to college, they need to take placement exams to measure their college proficiency in mathematics and English. Nationwide, more than half of entering college students in the United States are placed into developmental courses. (Callan, Finney, Kirst, Usdan, & Venezia, 2006; Goldrick-Rab, 2010; Houser & An, 2014; Mulvey, 2009; Venezia & Jaeger, 2013).

Academic factors. Historically, it has been the K-12 system's responsibility to prepare students for college-level education. However, research shows that misalignment between K-12 curriculum standards and college admissions benchmarks creates confusion and results in a lack of preparedness for incoming college students (Houser & An, 2014). At the high school level, students are required to complete several mathematics courses to illustrate college readiness. In contrast, in higher education, college readiness is determined by scores on college placement exams or on college entrance exams like the ACT, SAT, or Early Assessment Program (EAP) (Foote, Schulkind, & Shapiro, 2015; Houser, & An, 2014; McCormick & Lucas, 2011).

The ACT, for example, is a curriculum-based college entrance exam that consists of four subjects, including English, Mathematics, Reading, and Science Reasoning (Foote, Schulkind, & Shapiro, 2015). Based on data from the National Center for Education Statistics, over the last decade, only 12% of African-American students and 13% of Latino students took the SAT or ACT (Foote, Schulkind, & Shapiro, 2015; Houser & An, 2014). Furthermore, in 2010, only 43% of students who took the ACT reached the benchmark. While 52% of White and 68% of Asian students were college ready, only 13% of African-American and 27% of Hispanic students reached the benchmark (McCormick & Lucas, 2011). Some research shows a correlation between the ACT benchmark scores and students success rate in entry college-level mathematics courses. In 2007, based on ACT national data, students whose mathematics score was determined to be 22 or higher were associated with a 50% chance to get a grade of B or better and a 75% chance of a C or better in entry college-level mathematics courses. Similarly, students who have scores of 610 or higher in SAT mathematics are more likely to have first-year college GPA of 2.7 or higher (Li et al., 2012; McCormick & Lucas, 2011).

On the other hand, results of many studies indicate that SAT or ACT scores are inconsistent measures of college readiness and college enrollment (Combs et al., 2010; Foote, Schulkind, & Shapiro, 2015; Kim, 2014; Kowski, 2013; Venezia & Jaeger, 2013). Data from the State of Colorado indicate that receiving the score report, after taking the ACT, had no effect on high school students' decision to enroll in college (Foote, Schulkind, & Shapiro, 2015). In one study, traditional regression discontinuity design was used to offer three reasons for this finding. First, students may already know how

college-ready they are, but they decide not to attend college for reasons such as financial difficulties. Second, the college readiness results may not be reported in a clear way that is understandable to some students and therefore, many students may miss this important information. Finally, students may receive the college readiness report too late to allow them to adjust their college path. Thus, changing how the ACT results are presented, and the timing of dissemination may help over 1.8 million students each year who take the ACT to make a more informed decision about their college education (Foote, Schulkind, & Shapiro, 2015).

California's Early Assessment Program (EAP) provides an assessment of college readiness in English and mathematics for California State Universities (CSU) to help students prepare for placement exams and avoid developmental courses. Students who score high enough on the EAP (or on the SAT or ACT) are exempt from taking college placement tests and can go right into college-level courses. The Mathematics EAP consists of 15 additional questions added to the end of the California Standards Test (CST) taken by high school juniors to determine college readiness in three categories: ready for college, ready with conditions, or not ready for college in the CSU system (Houser & An, 2014). Students who are ready for college do not need to take any other class or tests to enter college-level courses. Students who are ready with conditions are required to take Algebra II or higher mathematics courses during their senior year; and students who are not ready for college are required to take developmental mathematics courses. Research indicates that EAP mathematics is one of the best tools to distinguish students who are ready to take college-level mathematics courses (Houser & An, 2014; Li et al., 2012; Prather & Bos, 2014; Venezia & Jaeger, 2013).

College assessment and placement policies have a great impact on students' first semester courses (Houser, & An, 2014; Li et al.,2012; Prather & Bos, 2014). Both qualitative and quantitative data were used to focus on the current assessment and placement policies (A&P) for developmental mathematics courses in the Los Angeles Community College District (Prather & Bos, 2014). Research reveals that faculty and administrators do not have the necessary technical expertise or resources to determine student placement. Additionally, every community college uses different cut scores to assign students to developmental courses (Prather & Bos, 2014). Data indicate that most entering college students across Los Angeles Community College District are placed in the two lowest levels of the developmental mathematics courses. Based on California Assembly Bill 743, all California community colleges are required to develop a common English and mathematics assessment system. One positive aspect of this policy is that students can transfer their test scores to other colleges, which reduces statewide institutional costs associated with testing. Finally, faculty, college administrators, and state officials need to collaborate to improve the A&P system to place entering college students appropriately and facilitate the transfer or completion of the associate's degree (Prather & Bos, 2014).

Colleges usually use a single measure to place students in developmental courses: standardized exam scores on the SAT, ACT, ACCUPLACER, or ACT Compass (Fields & Parsad, 2012). Recent research suggests that over reliance on standardized exam scores may result in the misdirection of students to developmental courses when, in reality, they could have succeeded in college-level courses. The research also shows that in two large community college systems nearly a quarter to a third of students may have been

misplaced into developmental courses when they could have succeeded in college-level courses (Scott-Clayton et al., 2014).

To assign students to the highest level of coursework in which they are likely to succeed, colleges are beginning to use students' high school grades in specific subjects and their cumulative high school grade point average in addition to standardized exam scores (Bracco et al., 2014; Dadgar et al., 2015; Scott-Clayton, 2014). For example, several California community colleges are using high school grades in specific subjects and cumulative high school grade point average to place students. Those colleges have found that students who earned higher grades in high school do well in college English and mathematics. The research also indicates that students' grade in the highest-level mathematics course taken in high school is an important predictor of college mathematics grades (Willett & Karandjeff, 2014). Cumulative high school grade point average may be a useful predictor of college grades across any subject because it is not just a measure of cognitive ability; it is also a cumulative measure of academic achievement in multiple subjects across a student's high school career and thus may signal a broader range of skills related to college readiness, such as a student's academic persistence and motivation (Bowen et al., 2009).

College readiness programs also show a positive impact on mathematics placement test, mathematics readiness, and student course behavior such as attendance, participation, and time management (Li et al., 2012; Prather & Bos, 2014). Several researchers use the computer-adaptive placement test (COMPASS) to place students in appropriate mathematics courses; COMPASS employs four variables for analysis: initial mathematics readiness, course behavior, mathematics knowledge, and course success (Li

et al., 2012). The results indicate that better course behavior increases knowledge gained in the course. Additionally, proper placement of students in adequate mathematics courses has a direct relationship with course success. The research also suggests that when at-risk students are identified in a timely manner, and are provided interventions to address their needs, their enrollment and GPA increase (Li et al., 2012). Many scholars believe that faculty, college administrators, and state stakeholders need to improve the A&P system to place entering college students appropriately (Houser & An, 2014; Li et al., 2012; Prather & Bos, 2014).

Completion of higher-level mathematics impacts students' academic and professional success. Research reveals that taking rigorous and advanced mathematics courses in high school increases the chance of attending college (Aughinbaugh, 2012; Hodara, 2013; Iatarola, Conger & Long, 2011; Long, Iatarola, & Conger, 2009; Maxwell et al., 2003; McCormick & Lucas, 2011; Riegle-Crumb & Grodsky, 2010). Mathematics allows students to tap into their analytical skills, engage in critical thinking, and practice interpreting data. These are all pragmatic skills that will benefit students after degree completion. Even when students are admitted to college, a lack of mathematics readiness often limits their choices of college majors and careers. Research reveals that the mathematics courses taken in high school contribute significantly to students' mathematics college readiness (Aughinbaugh, 2012; Long, Iatarola, & Conger, 2009; McCormick & Lucas, 2011). Many educational stakeholders have argued for years that, in order for high school graduates to be college ready in mathematics, they must have taken and passed the minimum requirement, which includes Algebra II. However, only twelve states have set Algebra II as the minimum graduation requirement (Long, Iatarola,

& Conger, 2009). Several studies about mathematics college readiness note that high school students who take higher mathematics courses than Algebra II score higher on standardized tests and are placed into college-level mathematics courses (Aughinbaugh, 2012; Long, Iatarola, & Conger, 2009; Maxwell et al., 2003; McCormick & Lucas, 2011). In addition, there is a correlation between mathematics college readiness and degree completion. Students who need remediation in mathematics are considered at-risk for academic success and they are less likely to attain a college degree (Aughinbaugh, 2012; Li et al., 2012; McCormick & Lucas, 2011). Based on the ACT report in 2007, students who are prepared for college mathematics are more likely to enroll in college, earn college GPA of 3.0 or better, and return to the same institution for their second year of college (McCormick & Lucas, 2011).

When it comes to educating high school students in mathematics, schools play a significant role in strengthening or weakening inequalities between students from different socio-economic backgrounds. Specifically, unequal access to rigorous high school mathematics courses is an important factor in the lack of mathematics college readiness for socioeconomically disadvantaged students (Aughinbaugh, 2012; Kowski, 2013; Maxwell et al., 2003). Research has shown that schools in low socio-economic communities do not offer advanced mathematics courses that prepare students for college-level mathematics. For example, while 72% of high schools in the wealthiest districts offer Calculus, only 44% of high schools in high-poverty communities offer the course (Maxwell et al., 2003; McCormick & Lucas, 2011). Research suggests that students who are not college ready are often from low-income, minority, and immigrant non-native speaker backgrounds. To mitigate this disparity, communication with

immigrant parents about increasing college readiness among their children in the parents' familial language is essential (Mulvey, 2009).

The disconnect between K-12 curricula and college requirements is another important factor in accounting for the high level of developmental courses in higher education. Research indicates there is a gap between what is required for students to graduate from high school and what is needed to enter college and be placed into college-level courses (Conley, 2007; Kowski, 2013; Long, Iatarola, & Conger, 2009; McCormick & Lucas, 2011). High school teachers are focused on preparing students for state exams that are not aligned with college expectations in mathematics. Additionally, while mathematics college instructors expect a deep understanding of the fundamental and conceptual mathematics from high school students, high school teachers focus on covering a broad range of topics in advanced mathematics. Thus, aligning mathematics content of high school exit tests with mathematics college readiness standards is an essential factor to increase mathematics college readiness (Howell, 2011; Long, Iatarola, & Conger, 2009; McCormick & Lucas, 2011; Mulvey, 2009). Research also reveals that mathematics high school teachers with more experience correlate with fewer students needing college developmental mathematics courses (Howell, 2011; Wong 2013).

Non-academic factors. Some literature reveals that non-academic factors also influence college readiness. Even though, academic skills are needed to be successful in college-level courses, non-academic skills such as peer influences, parental expectations, time management, study habits, goal focus, self-advocacy, and social capital—not measured by standardized tests—are essential for being college ready (Barnes and Slate, 2014; Byrd & MacDonald, 2005; Lassila et al.,2009; Long, Iatarola, & Conger, 2009).

Research indicates that parents who felt greatly responsible for their children's college readiness, and had high expectations for them to attend college, even when the parents themselves were not college educated, had a positive impact on their children's education (Barnes & Slate, 2014; Venezia & Jaeger, 2013; Yamamura, Martinez, & Saenz, 2010). For example, Bourdieu's cultural reproduction theory explains that parents' levels of education, learning, and occupational and social success impact their children's academic success. In today's society, graduating from high school, enrolling in college, and obtaining a bachelor's degree will increase one's cultural capital and upward social mobility, which can also affect future generations. Some underrepresented students have the desire, ability, and persistence to obtain a college degree to increase their cultural, social, and economic capital that can be exceeded as cultural reproduction to future generations (Barnes & Slate, 2014; Mulvey, 2009).

Many scholars also emphasize gender, race, and socioeconomic status as determinants of college readiness in particular subjects. The need for mathematics remediation is remarkably high among low income, African-American, and Hispanic students. Female students are also less likely to be ready for college-level mathematics (Combs et al., 2010; Ganley & Vasilyeva, 2011; Garriott et al., 2013; Hodara, 2013; Houser & An, 2014; Lee, 2012; Long, Iatarola, & Conger, 2009; McCormick & Lucas, 2011; Nord et al., 2011; Russomanno et al., 2010). In a study on college readiness, in the state of Texas in 2006-2007, qualitative and quantitative data were used to understand the range that boys and girls differed in their college-ready performance in mathematics, and on the SAT and ACT tests. The results revealed that 53% of males met the basic mathematics requirement for college entry, as compared to 44% of females (Combs et al.,

2010). Moreover, only 29% of low-income high school students were enrolled in college preparatory classes as compared to 65% for high-income students. Similarly, 28% of African-American and 23% of Latino students attended college-preparatory classes as compared to 34% for White, non-Latino students (McCormick & Lucas, 2011). The research also indicates that males outperform females in standardized test results for mathematics college readiness; however, new research reveals that the gender gap has decreased (Ganley & Vasilyeva, 2011; Houser & An, 2014; McCormick & Lucas, 2011; Nord et al., 2011).

Several researchers conclude that the individual ownership of learning is an important component of college readiness (Mulvey, 2009; Stephens, Hamedani, & Destin, 2014; Tierney, Sablan, Conley, & French, 2014). They describe two conceptual models. First, a four-part model of college readiness that consists of thinking skills (the cognitive strategies), attitude toward an understanding of the content presented (key content knowledge), specific methods for an effective learner (key learning skills and techniques), and key transition knowledge and skills such as the knowledge required to select a college, apply effectively, and understand the culture of the college. Second, a five-part model of ownership of learning that includes elements of motivation and engagement, goal orientation and self-direction, self-efficacy, self-confidence, and persistence (Tierney, Sablan, Conley, & French, 2014). The results indicate that students who show ownership of learning can be successful in almost any learning environment, such as large classes and online settings where students have less interaction with the teacher. Strong ownership of learning can even compensate for less effective instructors and curricula (Tierney, Sablan, Conley, & French, 2014).

College Remediation

Estimates from a decade ago show that colleges spent about $1 billion per year on remediation programs (Martorell & McFarlin, 2011; Melguizo, Kosiewicz, Prather & Bos, 2014; Long, Iatarola & Conger, 2009; McCormick & Lucas, 2011). In a similar respect, research indicates only one-third of high school graduates have the minimum qualifications for a four-year university (Byrd & MacDonald, 2005; Callan, Finney, Kirst, Usdan & Venezia, 2006; Goldrick-Rab, 2010; Kowski, 2013; Li et al., 2012; Mulvey, 2009; Venezia & Jaeger, 2013). The most common approach to alleviate this problem is offering developmental courses to assist students who have weak mathematics and English skills.

Generally, colleges focus on four different types of interventions for improving students' progress in developmental education and into college-level courses, including (1) strategies that help students avoid developmental education by shoring up their skills before they enter college such as summer bridge programs; (2) interventions that accelerate students' progress through developmental courses by shortening the timing or content of their courses such accelerated developmental courses; (3) programs that provide contextualized basic skills together with occupational or college-level coursework such as mathematics for nursing program or mathematics for culinary arts; and (4) programs that enhance the supports for developmental level learners, such as advising or tutoring (Rutschow & Schneider, 2011).

There are two conflicting opinions about developmental courses. Supporters of developmental courses believe they allow underprepared students to develop the necessary academic skills to succeed in their college courses and to become academically

equal to their peers (Byrd & MacDonald, 2005; Callan, Finney, Kirst, Usdan, & Venezia, 2006; Goldrick-Rab, 2010; Kowski, 2013; Li et al., 2012; Long, Iatarola, & Conger, 2009; Mulvey, 2009; Venezia & Jaeger, 2013). In contrast, opponents claim that offering developmental courses is extremely costly, and that there is very little evidence to support that remediation improves student academic outcomes. These researchers claim that remediation may not be a viable solution to college readiness (Howell, 2011; Martorell & McFarlin, 2011). Quantitative data from Texas K-12 public schools, colleges, and the state's unemployment insurance system show that remediation programs have a small impact on labor market earnings and help students to become economically successful (Martorell & McFarlin, 2011). Based on this study, college readiness can be improved by aligning high school and college curriculum, and hiring caring, trained, and experienced teachers.

The literature reveals the importance of developmental mathematics in higher education as these courses prepare entering students for college-level mathematics (Aughinbaugh, 2012; Corbishley & Truxaw, 2010; Kowski, 2013; Long, Iatarola & Conger, 2009; McCormick & Lucas, 2011; Wong, 2013). As a result, many mathematics departments in different community colleges are under pressure to change their programs to increase their student success rate. In particular, the modular approach in teaching developmental mathematics courses has shown a positive impact on student success rates (Wong, 2013). A quantitative study investigated the process that Nevada State College initiated to take a modularized approach to their mathematics developmental classes. In the modular teaching approach, students spend as much time as needed to gain the appropriate knowledge and skills in a specific subject. The mathematics department

decided not to use mathematics software such as Assessment and Learning in Knowledge Spaces (ALEKS) or MyMathLab in developmental courses. They believed students in these classes needed to learn basic mechanics of lining up equal signs, showing their work, and general organization of presentation. The results indicate that this modular teaching approach in mathematics developmental courses can increase student success rate. Additionally, creating these modules, as well as uniform syllabus and common quizzes and exams, made it easier to work with the associate faculty to create uniformity (Wong, 2013).

Research reveals a positive relationship between dual credit high school courses and college readiness in reading, writing, and mathematics (An, 2013; Kim, 2014; Iatarola, Conger, & Long, 2011). One strategy to improve college readiness is to provide students with a college experience prior to their first semester in higher education. Dual enrollment is a program that allows high school students to take college courses and earn college credits. Many educators consider dual enrollment as one of the best and inexpensive strategies to prepare and transition underrepresented high school students to college. Because dual enrollment courses expose high school students to college materials, they prepare the participants for the rigors of college coursework (An, 2013; Kim, 2014). Research illuminates that most high school graduates who enroll in community college preparation programs, and complete them, are ready for college-level courses. The results of one quantitative study indicate several positive and negative relationships between students' participation in these programs and their college outcomes. First, dual credit hours earned had a positive relationship with college readiness in mathematics. Second, dual credit hours earned had a weak negative

correlation to total college-level credit hours. Third, there was a stronger impact of dual credit on college retention for tech-prep participants. These findings suggest that encouraging participants to take a dual credit course in high school may result in greater college readiness (Kim, 2014).

Summer Bridge Programs

Many colleges have instituted a summer bridge program—a program for first-year students—to help with the academic transition to college. Many researchers conclude that summer bridge programs are one of the best remedies to increase college readiness among underrepresented students as they provide an opportunity to involve and educate families about college expectations. Also, summer bridge programs have positive impacts on the participants' performance in college placement tests, first year GPA, retention, persistence, graduation rate, and overall college academic performance (Cabrera, Miner, & Milem, 2013; Ghazzawi & Jagannathan, 2010; Murphy, Gaughan, Hume, & Moore, 2010; Raines, 2012; Reisel, Jablonski, Hosseini, & Munson, 2012; Russomanno et al., 2010; Stephens, Hamedani, & Destin, 2014; St. John et al., 2014; Sablan, 2014). All summer bridge programs differ in their components and implementations, and most of them are designed for students to develop study skills and utilize different support services (such as tutoring and the library) while practicing college coursework (Cabrera, Miner, & Milem, 2013; Ghazzawi & Jagannathan, 2010; Murphy, Gaughan, Hume, & Moore, 2010; Reisel, Jablonski, Hosseini, & Munson, 2012). Research also indicates that summer bridge programs help low-income, first generation, and minority students successfully transition to college; but they are usually

among the first programs to get cut when resources are limited (Cabrera et al., 2013; Stephens, Hamedani, & Destin, 2014).

Several studies measured the effectiveness of summer bridge programs on mathematics placement test scores of entering college students, and most revealed positive results (Cabrera, Miner, & Milem, 2013; Murphy, Gaughan, Hume, & Moore, 2010; Raines, 2012; Reisel, Jablonski, Hosseini, & Munson, 2012). For example, researchers employed quantitative data to examine the effects of the summer bridge program for entering engineering and computer science students at the University of Wisconsin-Milwaukee from 2007 to 2010 (Reisel, Jablonski, Hosseini, & Munson, 2012). This program was offered to students who were placed in a course lower than Calculus. The results indicated that the students in the summer bridge program improved their mathematics placement test. Students who were enrolled in this program used the Assessment and LEarning in Knowledge Spaces (ALEKS) software package as a primary instructional tool. Additionally, students had access to instructors to provide guidance. In 2007 and 2008, this program was offered online and on-campus with additional instruction. In 2009 and 2010, the program was offered exclusively online which had a required residential component as well as additional engineering activities for the students. The results of these four summer bridge programs indicate that better mathematics preparation and the amount of time spent by participants on the software were two important factors of students' success on the mathematics placement test. Additionally, the on-campus version of the program was more successful than the online version since it provided the participants with a set structure, immediate assistance, and feedback from the instructors. The on-campus program showed a 74% student success

rate compared to a 46% success rate for the online version (Reisel, Jablonski, Hosseini, & Munson, 2012). This result supports Wong's (2013) conclusion that using mathematics software as a primary tool of teaching decreases students' success rate.

While college attendance stands at 80% for students from the upper middle classes, only 57% of students from the lower middle classes attend college (Ghazzawi & Jagannathan, 2010; Maxwell et al., 2003; McCormick & Lucas, 2011). Colleges know the value of exposing and preparing underrepresented students to the college experience. In one mixed-methods study, the impact of a college outreach program that targets low-income and first-generation college students was assessed (Ghazzawi & Jagannathan, 2010). This program was called REACH Business Camp and its objective was to make college accessible to any student by exposing them to everyday college life. The program allows students to live on campus and experience extra-curricular activities to illustrate the college environment. Based on this study, 95% of students who attended the REACH program later enrolled in college, showing a positive relationship between participation in the camp and college attendance (Ghazzawi & Jagannathan, 2010).

Intervention Programs and Support for Underrepresented Students

Minority and low-income students do not receive the same quality of education as other students (Ghazzawi & Jagannathan, 2010; Stephens, Hamedani, & Destin, 2014; Venezia & Jaeger, 2013). Many researchers study intervention programs with the aim of reducing the social-class achievement gap for first-generation college students, a large number of whom are from lower socioeconomic backgrounds. The results of these studies shine the light on significance of TRIO programs that expose middle and high school students to information about preparing for college, participation in learning

activities, and enrolling in courses that prepare them to succeed in college-level classes. TRIO was given its name after the first three programs; TRIO Talent Search, Upward Bound, and GEAR UP. TRIO programs are outreach and student services programs designed to serve low-income, first-generation college students, and students with disabilities to advance from middle school to post-baccalaureate programs. They are governed, funded, and implemented by the United States Department of Education (Ghazzawi & Jagannathan, 2010; Gullatt & Jan, 2003; McCormick & Lucas, 2011; Pitre & Pitre, 2009; Stephens, Hamedani, & Destin, 2014). Research shows a positive relationship between TRIO programs and college attendance among underrepresented and economically disadvantaged students (Pitre & Pitre, 2009). TRIO Talent Search program targets minority students who have shown potential and interest in attending college to encourage them to pursue higher education. TRIO Upward Bound program provides academic support for high school students in English, mathematics, and sciences. Finally, the GEAR UP program work with middle schools and high schools to provide counseling and other college outreach services to students with a low-socioeconomic and students of colors (McCormick & Lucas, 2011). GEAR UP provides professional development opportunities for middle and high school teachers, counselors, and administrators so they may provide assistance to students who are enrolled in college developmental courses. Additionally, TRIO programs address the financial aid barrier to college by providing scholarships to participants (Gullatt & Jan, 2003).

Many higher education institutions have implemented intervention programs to better transition underrepresented students into their freshman year (Ghazzawi & Jagannathan, 2010; Stephens, Hamedani, & Destin, 2014; Venezia & Jaeger, 2013).

Some researchers created an intervention program to study how entering college students' backgrounds can impact their college experience (Stephens, Hamedani, & Destin, 2014). In this intervention, a demographically diverse group of junior and senior college students shared stories with incoming students about how they adjusted to and found success in college. The results indicate that many first-generation underrepresented students lack knowledge about how to select a major, take advantage of college resources, find an internship, or build their resumes. These researchers also examined whether educating first-generation underrepresented students about the meaningfulness of being a first-generation college student can improve transition to college. This intervention program reduced the social-class achievement gap among first-generation college students by 63% at the end of the first year (Stephens, Hamedani, & Destin, 2014).

Research shows the relationships between social-class, self-efficacy, and outcome expectations can be compensated through learning experiences (Garriott, Flores, & Martens, 2013). Social-class is a status hierarchy in which individuals and groups are classified on the basis of economic success and wealth. Self-efficacy is the belief in one's ability to succeed in a specific situation or accomplish a task. One's sense of self-efficacy plays a major role in how one approaches goals, tasks, and challenges. Outcome expectation is what a student would like to gain from obtaining a college degree. For example, some students desire to be engineers to earn a decent salary while others pursue the field because they are passionate about making new products. Social Cognitive Career Theory (SCCT) is used to predict the intentions of a group of low-income, first-generation, and college students of color in mathematics and science (Garriott, Flores, &

Martens, 2013). Some of the contextual variables in SCCT are social-class, learning experiences, as well as supports and obstacles to educational life. Many researchers believe that the social-class achievement gap among underrepresented college students can be reduced through guiding and remediation programs that specifically target them (Stephens, Hamedani, & Destin, 2014; Garriott, Flores, & Martens, 2013).

Data indicate that students of color, compared to their White peers, are less prepared for Science, Technology, Engineering, and Math (STEM) courses, and experience lower persistence rates (Garriott, Flores, & Martens, 2013; Houser & An, 2014; Lee, 2012; McCormick & Lucas, 2011; Riegle-Crumb & Grodsky, 2010; Russomanno et al., 2010). Additionally, approximately seven out of ten STEM workers in the United States are non-Hispanic Whites (Garriott, Flores, & Martens, 2013). To address these disparities, some research and interventions promote STEM career selection among college students of color. The results indicate that self-efficacy and outcome expectations are two important factors in choosing a STEM career. Furthermore, several researchers claim that parental support for students of color is positively related with academic performance (Garriott, Flores, & Martens, 2013).

Teachers also play an important role, particularly regarding the quality of curriculum, and advocating for appropriate changes in high-poverty urban high schools. One mixed-methods study from the University of Wisconsin investigated the relationship between student success and teacher effectiveness. The results illuminate three major findings. First, teachers who were trained to employ quality management tools to align curriculum revealed structural, curricular, and instructional gaps in student learning. At the same time, these teachers felt empowered with their new skills and actively sought

leadership roles. Second, the existing mathematics courses in these high schools did not sufficiently prepare students for the college placement test. Third, high school students in high-poverty school districts are not prepared for college-level mathematics coursework (Bales & Akdere, 2014). These results show the importance of proper funding and teacher training (Bales & Akdere, 2014; Yamamura, Martinez, &Saenz, 2010).

Summary

It is well documented in the literature that many entering college students in the United States are unprepared for a college education (Byrd & MacDonald, 2005; Callan, Finney, Kirst, Usdan & Venezia, 2006; Goldrick-Rab, 2010; Li et al., 2012; Venezia & Jaeger, 2013). Increasing efforts at different levels, including states, districts, schools, and educators, is vital to ensure that the new standards and initiatives can make significant changes in college readiness. Additionally, mathematics readiness plays a significant role in admission to college, broadening choices of college majors, and attaining a college degree (Aughinbaugh, 2012; Hodara, 2013; Iatarola, Conger, & Long, 2011; Long, Iatarola, & Conger, 2009; Maxwell et al., 2003; McCormick & Lucas, 201). In order to prepare high school students for college-level mathematics coursework, reforms should take a systemic and comprehensive approach to provide students with both academic and non-academic resources. These reforms are related to instructional changes, aligning high school curriculum and college expectations, and developing student support systems including abilities to navigate college academically, financially, socially, and psychologically (Venezia & Jaeger, 2013). Furthermore, expanding the existing efforts to help narrowing the gap between high school and college education is essential. For example, dual enrollment, summer bridge, and TRIO programs include

some opportunities that assist students to prepare for college (Cabrera, Miner & Milem, 2013; Ghazzawi & Jagannathan, 2010; Gullatt & Jan, 2003; Murphy, Gaughan, Hume & Moore, 2010; Pitre & Pitre, 2009; Raines, 2012; Stephens, Hamedani, & Destin, 2014; Sablan, 2014). Also, students who show responsibility for their own college readiness and actively seek college resources and information are better prepared for college-level courses (Yamamura, Martinez, & Saenz, 2010).

Assessing the impact of intervention programs is extremely important in improving college readiness (Cabrera, Miner, & Milem, 2013; Howell, 2011; Wong, 2013; Murphy, Gaughan, Hume, & Moore, 2010). Even though a majority of studies report the effectiveness of intervention programs, some have suggested otherwise (Howell, 2011; Martorell & McFarlin, 2011). Existing research indicates there is no single solution to increasing mathematics college readiness among underrepresented students. Although summer bridge programs assist in reducing inequality among entering college students, most of the existing research about summer bridge programs are related to student's retention, college GPA, self-efficacy, and social skills, and there is a major gap in studying intensive review programs that directly target mathematics placement test scores among students who are placed in developmental mathematics.

Areas for Future Research

Given the range of major efforts in place in high schools and colleges to help underrepresented students become ready for college coursework, it is difficult to isolate specific strategies that are more effective. However, looking across the spectrum of efforts, there is a gap in understanding the impact of intervention programs regarding mathematics assessment and placement in underrepresented students' success at

community college-level. Future research is needed to understand the impact of mathematics assessment and placement interventions on entering college students' success (Houser, & An, 2014; Li et al., 2012; Prather & Bos, 2014). Additionally, there is little or no information about the design and the implementation of these programs; thus, they are less effective tools for college educators and administrators. Considering these issues will present opportunities for future directions of the summer bridge programs that prepare students for the mathematics placement test, helping them to reach their educational goals in a shorter period of time. The results of future studies on impact of mathematics placement intervention programs can assist entering college students, specifically, low income, African-American, and Hispanic students, to take a shorter path to college-level mathematics courses. One promising approach to address this problem is the Mathematics Success program that has been implemented at Oceanview community college. The Mathematics Success program provides enrichment instruction in mathematics for students admitted to any program at the college for the purpose of improving placement test scores, and it enables students to take a shorter path to transfer-level mathematics courses.

Chapter Three: Methodology

Introduction

Developmental education has become a major facet of community college coursework in the past three decades. Due to the complexity of the 21st century's workforce, and the enhanced educational opportunities for all students, community colleges' enrollment has increased dramatically (Wildman & Roueche, 2003). However, not all students are prepared to meet the demands of collegiate expectations. A recent study finds that 30% of incoming students do not meet basic college level reading and writing skills and 60% do not have college level mathematics proficiency (Bailey, Jeong, & Cho, 2010). This has placed a new burden upon the nation's community colleges to create and implement innovative and meaningful developmental programs. With the increasing number of students identified as developmental students in mathematics, reading and writing, these issues have been great concerns for community colleges (Wildman & Roueche, 2003). Despite the concerted efforts to improve college readiness through coursework, testing, and assessment, there have been minimal improvements and a dire need to bridge the achievement gap (Bares & Slate, 2014).

For most entering community college students, an assessment center is one of the first places they will visit on campus to determine their proficiency in mathematics, reading, and writing. Placement exams are significant assessments that determine many students' college trajectories (Hughes & Scott-Clayton, 2011). Over half of entering community college students are placed into at least one developmental course, placement is based primarily on scores from these assessments (Hughes & Scott-Clayton, 2011;

Scott-Clayton, Crosta & Belfield, 2014). Despite the large numbers of students entering developmental courses, recent research fails to find evidence that placement into remediation improves student outcomes (Hughes & Scott-Clayton, 2011; Scott-Clayton, Crosta & Belfield, 2014). In fact, research indicates students placed into the lowest level of the developmental mathematics have a college-level mathematics completion rate in the single digits (Byrd & MacDonald, 2005; Kirst, 2008; Ngo & Melguizo, 2015; Prather & Bos, 2014). Thus, studying placement process and polices as well as placement test preparation programs is vital.

While several studies measured the effectiveness of summer bridge programs on mathematics placement test scores of entering college students, and most revealed positive results, there is a void of research that reveals the structure and application of such programs. A more transparent review would stand to benefit university professionals working towards improving college readiness (Cabrera, Miner, & Milem, 2013; Murphy, Gaughan, Hume, & Moore, 2010; Raines, 2012; Reisel, Jablonski, Hosseini, & Munson, 2012). The gaps in the current literature have guided the researcher's decision to study the Mathematics Success program at Oceanview Community College through a design-based case study lens. This site is reflective of state and national trends in college readiness and findings from the study have the potential to inform the leadership at a broad array of programs and stand to help a large population of students attain their educational milestones.

Approximately 77% of entering college students at Oceanview Community College are placed into developmental mathematics courses. The name of the study site has been fictionalized to protect the confidentiality of the study site and student

participants. Any identifying information has been altered or removed to maintain confidentiality. The majority of these students are either students of color, first generation, returning adults, military veterans, and/or individuals with a disability. Three developmental courses are offered at Oceanview Community College: pre-algebra (mathematics 20), elementary algebra (mathematics 30), and intermediate algebra (mathematics 64). Based on data from the research department at Oceanview Community College, 12% of the entering college students are placed into mathematics 20, 34% in mathematics 30, and 16% in mathematics 64. Also, 15% of the students did not take the mathematics placement test and were automatically placed into mathematics 20. Additionally, based on the Oceanview Community College's classification of incoming students, all individuals who are in mathematics 20, 30, or 64 are labeled and "identified" as basic skills students (Mehan, 2000, p. 261). Data from mathematics placement tests from Oceanview Community College research office show that 73% of students who were placed into mathematics 64, 89% of students who were placed into mathematics 30, and 94% of students who were placed into mathematics 20 do not make it to the first level of transfer level mathematics and drop out of Oceanview Community College (California Community Colleges Chancellor's Office [CCCCO], 2015). These findings are consistent with the national trends in lack of college readiness for entering college students. Therefore, more research is needed to investigate and explore the factors that contribute to this problem.

One approach to address this problem is the Mathematics Success program that was implemented in summer of 2014 at Oceanview Community College. This program incorporates enrichment instruction in mathematics and is open to students admitted into

any program within Oceanview Community College who need to take a developmental mathematics course. This seven-day, intensive program strives to shorten the academic journey with transfer-level mathematics courses and improve students' scores on the mathematics placement test. The curriculum breaks down the various topics in the mathematics placement test over two hours of instruction and two hours of review per day.

In order to study the Mathematics Success program, the researcher began by examining the quantitative data of the program. This offered evidence on the overall effectiveness of this intervention designed to help entering college students advance to higher-level mathematics courses. The measure for success in the Mathematics Success program was based on the improvement in placement level of the participants. All participants take the mathematics placement test before starting the program and again after the program. This was mandatory because it helps determine an appropriate level that students should be placed in the program. Also, the result was used as a benchmark to see how much students improve their assessment results after attending the program. Throughout the three years that this program has been in practice, 95% of participating students proceed to place in a higher mathematics class after attending the program and taking the mathematics placement test. However, in order to make sense of these numbers, and to clarify any aspects of the program that are particularly effective or need further improvement, the researcher utilized a qualitative approach.

Research Questions

The researcher investigated why and how the Mathematics Success program was effective in helping such a large percentage of students pass their mathematics placement test. My specific research questions were:

1. From students' point of view, what aspects of the program were most helpful in increasing their placement test level?
2. From students' point of view, what aspects of the program should be changed to make the program more effective?
3. From program instructional staff's point of view, what aspects of the program have the most impact on students' ability to increase their placement level?
4. From program instructional staff's point of view, what aspects of the program should be changed to make the program more effective?
5. Is there a change in placement test scores between pre-test scores (T1) and post-test scores (T2) after attending the program?
6. How much of the variance in the change in the students' scores on the placement test can be explained by gender, ethnicity, and previous mathematical skills?

Design-Based Case Study

To address the aforementioned questions the researcher employed a design-based case study approach to study the Mathematics Success program. This methodology was viewed as appropriate because it describes and evaluates an intervention or phenomenon within a real-life context (Cobb, Jackson & Dunlap, 2014; Baxter & Jack, 2008). DBR is

a framework that orients the use of other specific methods and techniques, such as video, interviews, and statistical analysis (Reimann, 2011). DBR is usually used to study innovations that have been in practice for an extended period of time in order to develop new theories and practices that can be used by interested practitioners in the field (Sawyer 2005). Additionally, DBR is often employed to make educational research more relevant for classroom practices (Reimann, 2011).

DBR is used to study learning in environments that are designed and systematically changed by the researcher (Sawyer 2005). In general, design-based research is conducted when research problems have the following two characteristics. First, the goal is to understand either how students develop specific forms of mathematical practice or how teachers develop particular forms of instructional practice. Second, current research on the process of supporting the development of the main practice is inadequate and cannot inform the formulation of viable instructional or professional development designs (Cobb, Jackson & Dunlap, 2014). At this time, the current research on placement tests brush up programs is inadequate to either inform the practitioner community or provide insight to design an efficient and sustainable refresher program. Thus, the researcher chose a design-based case study for the purpose of informing a practitioner-based community to design an effective program.

Most higher education programs subsist within larger organizational change. Since the summer of 2014 when the Mathematics Success program was implemented for the first time, two major changes took place at Oceanview Community College: the Multiple Measures Assessment (MMA) and the Common Assessment Initiative (CAI). MMA refers to the use of more than one indicator of college readiness to place entering

students into college-level coursework. The most commonly used multiple measures are a combination of high school grade point average (GPA) and standardized placement tests (Dadgar, Collins, & Schaefer, 2015; Scott-Clayton, Crosta & Belfield, 2014). The Multiple Measures Assessment Project is a collaborative effort led by the Research and Planning Group for California Community Colleges (RP Group) and Educational Results Partnerships' Cal-PASS Plus system, with support from the California Community Colleges Chancellor's Office (CCCCO). MMA has three primary objectives:

1. Development of a data warehouse: includes creation of a secure, large, and robust data warehouse to collect, store, and analyze multiple measures which will include high school transcript and test data, as well as placement test data for each community college.
2. Creation of a comprehensive analytical model: includes identification, analysis, and validation of known multiple measures data points, and leveraging of predictive analytic software to identify new data points that can serve as effective multiple measures.
3. Development of user tools for assessment and placement using multiple measures: includes the engagement of pilot colleges throughout the process to assist in development of the analytic tools and user interface, and to test the tools and models using local college data supplied through the data warehouse (Research and Planning Group, 2016).

Oceanview Community College Mathematics Department agreed to use the MMA for assessing entering college students in February 2016. As a result, ten categories were formed to use as guidance tools for placing students. After implementing the MMA, more entering college students were placed into the college-level mathematics

courses. The students who do not meet the requirements including the required high school GPA or the mathematics classes from high school will be placed into developmental courses. These students may choose to attend the Mathematics Success program to get adequate preparation for taking the mathematics placement test and potentially be placed in a higher level mathematics course. Consequently, since these students do not have the required GPA or did not take the required mathematics class in high school, they may have lower mathematical skills and need more practice to understand the mathematical concepts. Thus, this may affect the Mathematics Success program's design to address the new populations' needs.

Based on California Assembly Bill 743, all California community colleges are required to develop a common English and mathematics assessment system. One positive aspect of this policy is that students can transfer their test scores to other colleges, which reduces statewide institutional costs associated with testing (Prather & Bos, 2014). In December 2013, Common Assessment Initiative, which is collaborating with Educational Results Partnership (Cal-PASS Plus), Saddleback College, and the Academic Senate for California Community Colleges were charged to develop and implement a common assessment system (CAS) for the state. The Common Assessment System will provide colleges with effective and valid English, English as a Second Language, and mathematics assessment instruments; a reliable testing platform; student test preparation resources; college research guidance; and professional development. The Common Assessment System will leverage the work of the Multiple Measures Assessment to provide institutions access to K-12 data and other multiple measures that can be linked

with college data to effectively place students into college curricula (Research and Planning Group, 2016).

The Common Assessment Initiative has not yet been implemented at Oceanview Community College. The CAI is currently under development with plans to launch the new instrument in 2017. Since faculty at the Oceanview Community College are aware of this impending change, conversation around assessment and placement have been happening more frequently and with more urgency. The CAI may affect the Mathematics Success programs' curriculum and design.

Research Design: Settings and Participants

It is important to offer a conceptual framework as a paradigm for studying the Mathematics Success program. Part of this conceptual framework included design-based research (DBR). DBR is not a specific data collection and analysis method, but rather a framework that orients the use of other specific methods and techniques, such as video, interviews, and statistical analysis (Reimann, 2011). The goal of DBR is to examine learning, as it unfolds within a naturalistic context that contains innovations that have passed through multiple iterations, in order to develop new theories and practices that can be used by interested practitioners in the field (Sawyer 2005). Educational researchers have been using design-based methods to develop powerful technological tools, curricular interventions, and especially theory that can be used to improve the teaching and learning process (Bransford, Brown, & Cocking, 2000; Sawyer 2005). Design-based research provides rigorous empirical grounding to theoretical claims and explanations in order to expose design elements and mechanisms and its articulation of the conditions through which these mechanisms were established. A well-presented and carefully

conducted design narrative provides others insights into the challenges and opportunities that might emerge for other practitioners, as well as strategies for navigating the mechanisms effectively (Sawyer 2005).

According to educational researchers who use DBR, the complexity of real-world practices must be recognized, understood, and integrated as part of theoretical claims. From this perspective, experimental designs that examine teaching and learning as isolated variables within a laboratory or other artificial contexts will lead to understandings and theories that are incomplete. Thus, experimental studies can certainly validate theories and provide rich examples and case narratives for informing how to design and implement a theory within the context of real-world practice (Sawyer 2005).

The study included two phases of data collection and analysis. In phase one of the study, the researcher identified, surveyed, and interviewed eleven former students of the program representing different genders and ethnicities as shown in table 1. After analyzing the data from former students, four big ideas emerged and served as new interventions in the Mathematics Success program that was offered in January 2017. In phase two of the study, fifteen students representing different genders and ethnicities who attended the program in January 2017 as well as all fourteen instructional staff were surveyed and interviewed.

Participants. In the study of the Mathematics Success program, the participants included the person in charge of the program, instructional staff, and the former and current students. All participants were involved in the study of the Mathematics Success program in the form of collecting data, taking an online survey, conducting interviews or

being interviewed among others so their point of views were heard as the participants of the program.

In phase one of this study, the researcher identified eleven students who participated in the Mathematics Success program in the past. Using purposive sampling out of the pool of students who completed this program in the last two years, eleven students were chosen for interviews (Johnson & Christensen, 2008). These are students whose pre-placement test scores were low and placed in developmental mathematics, but after completing the program, their post-placement test scores improved and they were placed in a higher mathematics class such as Intermediate Algebra (mathematics 64) or a transfer level course. Seven of the participants were male and four were female. In addition, nine of the participants successfully were placed in a higher mathematics course after completing the program and taking the placement test and two of them were not placed in a higher mathematics class because of their low scores in the mathematics placement test. The ethnicity of the group included four Latinos (two females and two males), three males African-American, and four Caucasians (two females and two males). Table 1 provides an overview of the study participants: pseudonyms so that each participant has a personal name yet their identity is protected, gender, ethnicity, time and the mathematics level they attended the Mathematics Success program.

Table 1. Former students who participated in the study

Participant	pseudonym	Gender	Ethnicity	Time of Attending	Mathematics Level
1	Mike	M	Latino	December 2015	Intermediate Algebra
2	Joe	M	African-American	Summer 2016	Beginning Algebra
3	Beth	F	Caucasian	Fall 2014/ Spring 2015	Beginning Algebra/ Intermediate Algebra
4	Lisa	F	Caucasian	December 2014/Spring 2015	Beginning Algebra/ Intermediate Algebra
5	Mark	M	Caucasian	Summer 2015	Beginning Algebra/ Intermediate Algebra
6	Ted	M	African-American	Summer 2016	Beginning Algebra
7	Lucy	F	Latino	January 2016	Beginning Algebra
8	John	M	Caucasian	Summer 2015	Intermediate Algebra
9	Fred	M	African-American	December 2014/Summer 2015	Beginning Algebra/ Intermediate Algebra
10	James	M	Latino	Summer 2016	Intermediate Algebra
11	Molly	F	Latino	Summer 2014	Beginning Algebra/ Intermediate Algebra

The eleven participants in phase one were given an online survey prior to taking part in an interview. Their inputs were important because the researcher made sure they are maintained in the next session of the Mathematics Success program that was offered in January 2017.

Also, in order to understand the crux of the research questions, the researcher surveyed and interviewed fifteen students who attended the Mathematics Success program in January 2017 and completed the program. The interviewees were chosen using purposive sampling for the interviews from individuals who were and were not successful in the program (Johnson & Christensen, 2008). Six of the participants were male and nine were female. In addition, all participants successfully were placed in a higher mathematics course after completing the program and taking the placement test. The ethnicity of the group included six Latinos (three females and three males), two African-American (one female and one male), six Caucasians (four females and two males), and one female Asian. Table 2 provides an overview of the participants in phase two of the study; pseudonyms are utilized so that each participant has a personal name yet their identity is protected, gender, and ethnicity.

Table 2. Current students who participated in the program in January 2017 at the Intermediate Algebra level and took part in the study

Participant	pseudonym	Gender	Ethnicity
1	Angela	F	Latino
2	Sean	M	Latino
3	Alex	M	African-American
4	Lori	F	African-American
5	Keith	M	Caucasian
6	Kathy	F	Caucasian
7	Maria	F	Latino
8	Scott	M	Caucasian
9	Teresa	F	Asian
10	Tony	M	Latino
11	Jose	M	Latino
12	Susan	F	Caucasian
13	Ana	F	Latino
14	Jacki	F	Caucasian
15	Jeana	F	Caucasian

Additionally, fourteen program instructional staff members who completed the Mathematics Success program training were surveyed and interviewed. These individuals ranged from being new to the program to having two years of experience. Four of the participants were male and ten were female. The ethnicity of the group included four Latinos (three females and one male), eight Caucasians (five females and three males), and two females Asian. Table 3 provides an overview of the instructional staff who were surveyed and interviewed in the phase two of the study: pseudonyms so that each participant has a personal name yet their identity is protected, gender, and ethnicity.

Table 3. Instructional staff who participated in the study

Participant	pseudonym	Gender	Ethnicity
1	Mark	M	Latino
2	Christina	F	Caucasian
3	Tina	F	Latino
4	Terri	F	Caucasian
5	Linda	F	Caucasian
6	Luke	M	Caucasian
7	Monique	F	Latino
8	Claire	F	Caucasian
9	Vanessa	F	Caucasian
10	Lisa	F	Asian
11	Shane	M	Caucasian
12	Kim	F	Asian
13	Victoria	F	Latino
14	Andy	M	Caucasian

Following is a broad overview of the research design:

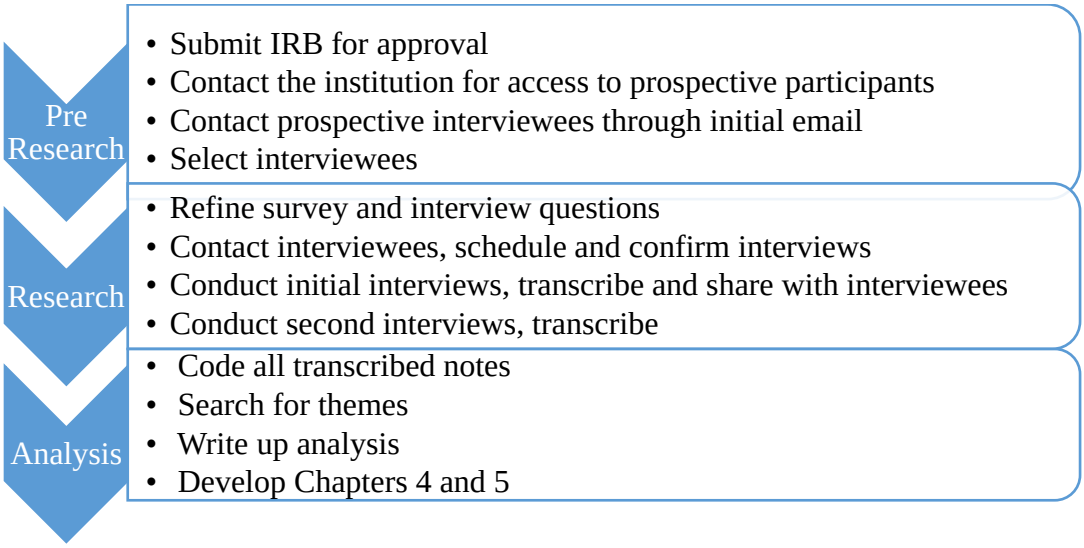

Figure 1. Research Design Flowchart

Procedures. This study involved two phases of data collection and analysis. In phase one of the study, the researcher surveyed and interviewed eleven former students who attended the Mathematics Success program in the last two years that the program has been in practice. A survey was sent to the participants through Qualtrics.com. The survey gathered background information and presented another platform for presenting interview questions. The survey data offered additional information supporting the themes that emerged from the interviews.

Additionally, all 11 former students were interviewed. All the interviews were semi-structured interviews, approximately 20 to 30 minutes in length. To ensure participants' comfort and familiarity with the environment, all the interviews were done in classrooms where they were either a staff member or student (diSessa, 2007). The researcher provided an ice-breaker or engaged in a conversation at the onset of the interview to make the interviewees more comfortable. The interviews were audio-recorded and transcribed. The gathered data from the phase one of the study help the researcher to answer the first two research questions.

After analyzing the data from the former students (surveys and interviews), four big ideas emerged that then served as interventions in the Mathematics Success program that was offered in January 2017. In the phase, two of the study, fifteen students who attended the program in January 2017 as well as all fourteen instructional staff were surveyed and interviewed. The gathered data from phase two of the study help the researcher to answer all the research questions presented in this study.

Instrumentation and Data Collection Procedures

Qualitative Data.

Student Survey. Prior to the interviews in both phases of the study, a survey through Qualtrics.com was sent to all participants to gain information on demographics including gender and ethnicity. The survey questions were the same as interview questions. The participants received the survey questions first so they could freely answer them without the presence of the researcher. The survey data offered additional information supporting the themes that emerged from the interviews. The surveys were anonymous so they could not be connected or related to the interviewees.

As seen in Appendix F, the first two survey questions ask participants about the time they attended the program and how they heard about the Mathematics Success program. Questions three and four asked the participants about their demographic followed by a question five asking them about their thoughts on the length of the program. Question six asked the participants about what aspect of the program specifically helped them succeeded. Question seven asked them whether they thought other types of support would have make the program more helpful or effective. Question eight and nine expanded question 6 in terms of what helped them succeed in the college level mathematics courses after completing the program. Question ten asked the participants more suggestions for improving the program. All the survey questions are listed in Appendix F.

Instructional Staff Survey: All instructional staff who agreed to participate in an interview received a survey link through Qualtiric.com prior to attending the interview.

The survey questions are listed in Appendix G. The first four questions on the survey asked for demographic data, and the next two questions inquire information about their roles and responsibilities in the program. Question six seeks information about specific supports that they provided to students in the program. Question seven inquires about the strategies utilized by the instructional staff to motivate the students during the program. Question eight asks for specific examples of the instructional staff interactions with the students after completion of the program. Question nine probes their thoughts about the length of the program. Question 10 and 11 ask their opinion about the available support for the students in the program. Finally, question 12 and 13 invite the instructional staff to share their opinion on the existing support available to them.

Interviews. In order to answer the first four research questions, the researcher surveyed and interviewed 11 former students of the Mathematics Success program. The interviewees were chosen using purposive sampling from the students who participated in the program (Johnson & Christensen, 2008). Also, all 14 program instructional staff were interviewed.

To answer research question one and two, the researcher asked the participants about different aspects of the program that were most helpful to the students. Also, they were asked about the aspects of the program that need to be changed to make the program more effective. The same two questions were asked from the program instructional staff in order to answer the research questions three and four.

Students were also asked about the registration process, length of the program, and redesigning the program. Moreover, the researcher sought information from the program instructional staff about their roles and responsibilities in the program, examples

of their interactions with the students after the program is over, the length of the program, and the available support for the students in the program. See Appendix E for a list of the interview questions.

Quantitative Data. All participants took the mathematics placement test before starting the program and again after the program. This is mandatory since it helps determine an appropriate level that students should be placed in the program. In order to answer the research question five and six, these results were used as a benchmark to see how much students improved their assessment results after attending the program. Moreover, the information about gender, ethnicity, level of education, last mathematics class taken, and how many years since their last mathematics class were collected from the participants before starting the program.

Data Analysis

Qualitative Data. Since there is minimal research on the Mathematics Success program, once the survey results were collected and the interviews were transcribed, the researcher used grounded theory (Strauss, 1987; Strauss & Corbin, 1994) to find the themes based on the survey responses and interview transcripts. Efforts were made to look for coherence in the survey results and the interviews to identify themes and patterns in the data. The researcher let the interview responses and other collected data tell the story, describe students' experience and their points of view toward the Mathematics Success Program.

It is important to limit bias, yet be understanding of the issues expressed. The first level of coding involved open coding of the students responses to the survey questions and the interview transcriptions. The key ideas related to the research questions were

labeled on the interviews line-by-line, several sentences or paragraphs. The researcher created reflective memos about potential interpretations of data. Next the concepts became categories. The second level of coding was to identify properties and dimensions of categories. Through constant comparison, the category received saturation when no new information appears about categories or their properties (Ericsson & Simon, 1993; Strauss, 1987; Strauss & Corbin, 1994). Through constant comparison, the researcher expanded the categories. Once they reach saturation, the researcher looked for substantive theory from core categories. This is what in grounded theory is called selective coding (Strauss, 1987; Strauss & Corbin, 1994).

To analyze staff interviews in the phase two of the study, the same procedures were performed. There was no a priori coding so the interview transcripts were analyzed through open-coding, constant comparison and selective coding (Strauss, 1987; Strauss & Corbin, 1994). The data were hand-coded using a reflexive lens (Emerson, Stetz, & Shaw, 1995), but not forced into preconceived understanding. The selection of a design-based case study is to tell the story of this research, and inform the practitioner-based community in a way that will allow for the design of an effective program. This is the overall goal of the analysis; it would not simply be analysis of words, but the findings would provide guidance and ultimately act as a map to direct the practitioner-based community in applying this research (Bransford, Brown, & Cocking, 2000; Sawyer 2005).

Quantitative Data. To answer the research questions five and six, multiple statistical tests were used. The first part of research question three was answered using paired sample t-test after checking the test's assumptions. To compare the variance in the

students' scores for multiple categories, the researcher used a one-way ANOVA (Keselman et al., 1998).

Table 4 summarizes the data collection and analysis used for each research question:

Table 4. Summary of the Method Section

	Data Collection	Data Analysis
RQ1: From students' point of view, what aspects of the program were most helpful in increasing their placement test level?	• Survey questions-Appendix F-Questions 6,7, 8, 9, 10 • Student Interviews-Appendix D-Questions 4, 5, 6, 7, 8 • Interview Transcripts • Researcher's Interview Notes	Grounded theory: • Open coding • Creating categories • Constant comparison • Substantive theory from core categories
RQ2: From students' point of view, what aspects of the program should be changed to make the program more effective?	• Survey questions-Appendix F-Questions 6,7, 8, 9, 10 • Student Interviews-Appendix D-Questions 4, 5, 6, 7, 8 • Interview Transcripts • Researcher's Interview Notes	Grounded theory: • Open coding • Creating categories • Constant comparison • Substantive theory from core categories
RQ3: From program instructional staff's point of view, what aspects of the program have the most impact on students' ability to increase their placement level?	• Survey questions-Appendix G-Questions 6,7, 8, 9, 10, 11, 12 • Staff Interviews-Appendix E Staff Interview Protocol-Questions 6, 8, 9, 10, 11 • Interview Transcripts • Researcher's Interview Notes	Grounded theory: • Open coding • Constant comparison • Selective coding

Table 4. Continued.

RQ4: From program instructional staff's point of view, what aspects of the program should be changed to make the program more effective?	• Survey questions-Appendix G-Questions 6,7, 8, 9, 10, 11, 12 • Staff Interviews-Appendix E Staff Interview Protocol-Questions 6, 8, 9, 10, 11 • Interview Transcripts • Researcher's Interview	Grounded theory: • Open coding • Constant comparison • Selective coding
RQ5: Is there a change in placement test scores between pre-test scores T1) and post-test scores (T2) after attending the program?	Students' scores on pre-placement and post-placement tests	• Descriptive statistics for pre- and post-scores. • Inferential statistics comparing the two scores using paired sample t-test
RQ6: How much of the variance in the change in the students' scores on the placement test can be explained by gender, ethnicity, and previous mathematical skills	Students' demographic data and their scores on the pre- and post-placement tests	• Descriptive statistics for students' demographic data and their pre- and post-scores • Inferential statistics comparing the two scores using One-way ANOVA

Validity

There were a number of validation strategies used in the study. The first was what Creswell notes as "prolonged engagement and persistent observation" (Creswell, 2013, p. 250). The researcher was familiar with most of the Mathematics Success program participants and therefore she may have established trust with the study participants. Interactions with the study participants happened over approximately seven to ten days, which may be considered sufficient contact time to establish validation of the research. To avoid exploitation of the researcher's trusting student teacher relationships,

the researcher did not teach in the Mathematics Success program in January 2017 to reduce prior contact with students.

A second validation strategy was ensuring the researcher's bias was clearly stated (Creswell, 2013, p. 251). The positionality explanation in this chapter notes that the researcher's position as the founder, designer, implementer, and the person in charge of the program, and how this may have played into the data collection process. While the researcher's position as the founder of the Mathematics Success program may have influenced data collection, her positionality also allowed for a more thorough analysis and opens doors. Her familiarity and experience with the program design and curriculum was critical in this research.

A third strategy that was employed to validate the study is called triangulation. It is a popular method that was used to verify the information by utilizing more than one – and often three – data collection points (Merriam, 2009). For example, in this design-based case study, as described earlier, the participants were surveyed anonymously with similar questions to the interview protocol so they could freely answer them without the presence of the researcher.

Chapter Four: Results

This chapter presents the findings from a design-based case study that examines the Mathematics Success program at Oceanview Community College by offering details of the study through surveys and individual interviews. The research questions that guided this study were:

1. From students' point of view, what aspects of the program were most helpful in increasing their placement test level?
2. From students' point of view, what aspects of the program should be changed to make the program more effective?
3. From program instructional staff's point of view, what aspects of the program have the most impact on students' ability to increase their placement level?
4. From program instructional staff's point of view, what aspects of the program should be changed to make the program more effective?
5. Is there a change in placement test scores between pre-test scores (T1) and post-test scores (T2) after attending the program?
6. How much of the variance in the change in the students' scores on the placement test can be explained by gender, ethnicity, and previous mathematical skills?

As part of the design-based case study, two phases of data collection were implemented. This two-phase process enabled the researcher to make changes to the program that are in line with the design-based case study approach (Cobb, Jackson &

Dunlap, 2014). Figure 2 shows an overview of the two phases of the study followed by the discussion of the results.

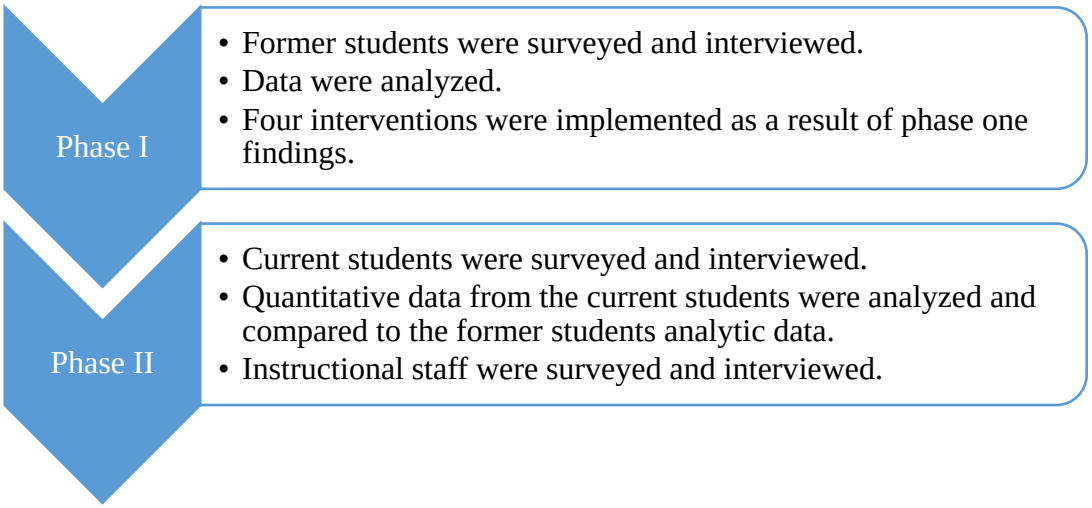

Figure 2. Two Phases of the Data Collection and Analysis Flowchart.

As indicated in the flow chart above, phase one of the study involved surveying and interviewing eleven former students of the Mathematics Success program. Based on findings from phase one, four interventions were implemented in the program that was offered in January 2017. Phase two of the study involved surveying and interviewing fifteen students who attended the program in January 2017 and all fourteen instructional staff.

The following paragraphs discuss the results from the phase one of the study. The researcher identified, surveyed, and interviewed eleven former students representing different genders and ethnicities as mentioned in the methods section. After analyzing the data from the former students, four big themes emerged that served as interventions for the second phase of the study. The researcher will reflect on the process of conducting interventions and initiating a second phase of data collection based upon the principles of

design-based research. The second part of this chapter discusses how these themes were implemented in the program. The last part of this chapter discusses the results of the data from surveys and interviews conducted at the end of phase two of the study. The phase two data collection was completed in January 2017, after students completed the Mathematics Success Program.

Phase one of data collection produced themes that answered the first two research questions. Phase two of the data collection produced findings that answered all six research questions. The eleven participants in phase one were given an online survey prior to participating in an interview. The following paragraphs summarizes the findings form the survey responses followed by finding produced from the interviews

Phase One Findings.

After thorough analysis of the surveys and interviews of eleven former students, four aspects of the program that were most helpful to increase participants' placement test emerged; *classroom tutors, tutoring services, supplemental practices, and Math Anxiety workshop.*

Classroom Tutors. One major aspect of the program that ten out of eleven former students identified as effective, beneficial, and helpful was the availability of tutors in the classrooms. Students mentioned that classroom tutors were beneficial since they provided instant assistance if students did not understand a concept, walked students through the process, helped them one-on-one when it was needed, and assist them so they could continue with the rest of class. Also, they mentioned the need for additional classroom tutors in order to cut down waiting time for the participants who need instant

help. For this category, sample written responses to the surveys are quoted below followed by excerpts from the interview transcripts.

From the survey data, students noted the significance of the classroom tutors in providing instance assistance when they did not understand a concept. One of the participants said:

> The tutor was very helpful because questions could be asked on the spot. Plus there was a tutor in the room milling about and assisting students so we can catch up with the class. Then, after a break, the last part of the day's session was spent with a teaching assistant who went over the material that was taught that day with the instructor. It was an excellent way to reemphasize what we learned and students could ask questions.

This example suggests that the student found the classroom tutors valuable as they provided immediate assistance to the participants so they can understand the mathematical concepts and increase their learning.

Similarly, John, a former student who failed Intermediate Algebra three times at Oceanview Community College emphasized the importance of classroom tutors for students who need additional help so they can ask their questions and get instant response. He said:

> For some reason, maybe, as a student who always had a difficulty and insecurity in math, I am kind of conditioned from repeated failure. I tell myself, do not ask questions because you don't want to look stupid. Then if you ask questions, it's bothersome because it seems like if you're one of the students that's not getting things, and the majority wants to move forward. It's like you're impeding people; so they get upset. Like why are you asking . . . this guy is asking questions again? So having tutors was helpful even if the teacher made it a friendly environment to ask questions. Sometimes, it was like I don't want to be asking the same questions again, over and over. So I saved my questions for the tutor who was walking in the classroom and he was checking with me to make sure I can understand the subject discussed.

Here John expressed his concerns of asking too many questions during lecture and what his classmate may think of him. However, the classroom tutors made sure to check in with him and answer any questions he might had in person and quietly. This helped John to clear any problems and move on with the rest of class.

Another student mentioned the importance of the tutors in students' understanding and learning mathematics as they walked the students through the process:

> … The tutor helping us in class was very helpful and respectful and knew a lot about the subject of math. He helped us to understand the concepts as he showed us the answer step-by-step, and I understood the material a lot better afterwards. I was prepared for my upcoming college-level class in the spring.

Here the survey participant noted that not only the tutor in the classroom helped him to understand the material discussed in the program by walking him through the process, but helped him to feel prepared for the next mathematics class. This is because the instructional staff reminded the participants that the mathematical concepts discussed in the program are also the foundation for many college-level mathematics courses.

Likewise, Mike voiced the same perspective when he said, "Well if I had any questions or if I was struggling or having a problem they would help me. They showed me step-by-step what to do and helped me out through the problem."

Similarly, Lucy found the classroom tutors very helpful as she noted:

> I really liked the fact that there are tutors in class because with one teacher it would have been hard for all the students to get help and even though we like to talk amongst ourselves to help each other out, I think having a tutor there helped even more. Because they also helped a big group of students who were working in groups. They come over and help eight students at a time so then the teachers are not stretching themselves too thin.

Lucy's quote indicates that not only did tutors help individual students in the classroom as needed, but they also assisted a group of students during the review time where participants work in groups and help each other out. She also mentioned that without tutors, one teacher could not provide the same learning assistance to all participants.

Another student mentioned the importance of one-on-one assistance provided by the classroom tutors:

> I enjoyed having the tutors for two hours. It helped wonders. The professor and tutors were amazing and made me feel like I was the only student in the class that they were helping! I got one-on-one help that I needed. Just keep doing the same; that would help wonders.

This student, like many others, voiced the value of tutors classroom in providing one-on-one support as she felt that she got the assistance she needed in order to be successful in the mathematics placement test.

From the interview data, the former students voiced the importance of the classroom tutors in helping students catch up with class. In my interview with Beth, a returning student, she simply said, "Having the tutor in the room was definitely helpful. She helped me to catch up with my classmates." Similarly, Mark, one of the students who attended the Mathematics Success program twice, stated the value of classroom tutors in absorbing the mathematical contents during the program and catching up with the rest of class:

> From time to time, I would be that person who did not 100% click with the rest of the classroom. I kind of needed some clarification so I can get right back to that stream of thinking, and I think that having assistance in the classroom and being able to raise my hand and ask questions was very helpful. The tutors came and kind of answered quick questions and that

> was helpful for me to get right back on track and move along with the class, and I did appreciate that.

This example suggests that classroom tutors provided an instant help for the students who needed some clarifications in order to be able to follow with the rest of class and not fall behind.

These examples suggest that the majority of the participants in the Mathematics Success program utilized the classroom tutors and found it valuable in their learning and understanding mathematical contents. This also implies that multiple tutors in the classroom were needed to provide immediate feedback, walk students through the process, and answer any questions they may have so they can continue with the rest of lecture.

Furthermore, ten out of eleven participants stated more available tutors in classroom are needed as it reduces the wait time and provides opportunities for students to ask more questions. For example, Mark addressed reducing wait time for students who needed help:

> I think at least an additional person would be helpful. Specifically for students like me who had a question in the middle. But some other students had more than one question and needed some real focus time. I think it would be helpful to have one more tutor because from time to time, there would be a student who had many questions, and was very concerned and didn't feel comfortable moving forward. And we want those students to get help, but we also have a room full of people who are ready to move forward. So maybe an extra person would be helpful to give extra time to those students.

Here Mark suggests adding at least one additional classroom tutor so students do not have to wait for a long time to get help so they can move forward with the rest of students. In addition, he mentioned that some students might have more questions and

that can hold up a tutor for a long time to help them while other students are waiting for the same tutor to assist them.

Similarly, Molly voiced that, “I think maybe having more tutors will be great. Maybe having one for three people just so groups are smaller, especially if people learn differently.” Here Molly reemphasizing the need for more classroom tutors so students can receive prompt and customized feedback.

Moreover, the following conversation took place between Mike and the interviewer on the significance of having additional classroom tutors.

> Mike: Um, I believe the only change needed would be probably adding more tutors available. May be 2 or 3 or 3 to 4.
> Interviewer: Inside the classroom or outside?
> Mike: Inside the classroom since there are a lot of students that might need help. The teacher doesn’t have enough time to go and check with every single one of the students. That’s probably one thing that was needed, yeah.
> Interviewer: So 1 instructor and then 2 or 3 tutors in the classroom?
> Mike: Yeah
> Interviewer: why?
> Mike: Because sometimes we were waiting around for the tutors to finish helping others.

Here Mike addresses that having additional classroom tutors can cut down the waiting time for students who need immediate assistance so they can continue with the lesson. Additionally, more tutors would provide opportunities for students to ask more questions and get the help they needed.

Likewise, Beth emphasized the importance of additional tutors in the program as she stated:

> Because sometimes when I wanted to ask questions they were helping someone else, or if I asked too many questions, I felt like I was keeping that tutor as my private tutor. I felt like I don’t want to ask them again

> because maybe someone else needed them. Yes, so it would be very helpful to have more tutors in the classroom.

This illuminates the need for more tutors in classroom as some students may hold back on asking questions because they wanted to give a fair chance to other participants to utilize the only tutor in the classroom.

Furthermore, survey participants noted the need for more classroom tutors as stated in the following responses:

> All around perfect program to begin with! One possible suggestion would be to incorporate maybe one more teacher assistant.

Another survey participant stated:

> More tutors available in the classroom, three of them would be enough. The program overall was very helpful and enjoyable, I really liked it.

Another survey participant noted:

> Individual students could, at times, halt progress of the class as a whole with multiple questions. Perhaps an extra assistant could take responsibility for these students when extensive assistance is required.

All these statements form survey and interview participants signified the need for more classroom tutors to provide immediate assistance for more students and to cut down the waiting time for the participants. Thus, the researcher categorized these responses as the need for more tutors in classroom and added additional tutors to the Mathematics Success program that was offered in January 2017.

Tutoring services. The second major aspect of the program that nine out of eleven former students identified as beneficial and valuable was additional tutoring, which also reflected the responses to the survey questions. Students mentioned the need for more tutoring hours outside the classroom so they can continue practicing and

learning the mathematical contents under the supervision of tutors, spending more time outside classroom to practice and ask more questions, and get one-on-one help when needed. For this category, sample written responses to the surveys are quoted below followed by excerpts from the interview transcripts.

From the survey data students noted that significance of the tutoring services in spending more time outside classroom to practice and ask more questions. One of the survey participants said:

> I think it would be helpful to have outside tutoring available for students so they could ask questions as they complete their homework.

This example suggests that some students felt more practice is needed in order to fully understand the lessons. They also felt more comfortable to practice under supervision of a mathematics tutor who can assist them one-on- one and answer their questions if needed.

In my interview with Mike, he stated the value of tutors outside classroom in absorbing the mathematical contents during the program.

> Tutoring services would be useful because after the program is done at 3:00 p.m. because students like me that need more help understanding the concepts can go and get help.

Joe, a former student who failed elementary Algebra three times at Oceanview Community College before attending the Mathematics Success program mentioned:

> During the tutoring, we had a better opportunity to understand the material and have more time to go over things that we went over in class to get ready for the assessment test.

Here Joe describes that tutoring services provided another learning and practicing opportunity for the students who did not fully understand the subject covered in class.

Lisa, a former student who attended the program twice stated how she utilized the tutoring hours to ask more questions and spend more time to get help on some specific problems to understand them better.

> . . . the tutoring portion, when you go and see a tutor and ask questions, I think it was very helpful because there were several things that I was not quite understanding as far as the different take home that we had. And spending 15 minutes with the tutor was very good. I thought it was a very good thing that helped me be successful in certain portions that I needed to understand.

Lisa describes tutoring services as an opportunity to get clarification on any unclear subject that can block deep understanding. She utilized after class tutoring to promote her learning and understanding of the problems in hand.

> Another survey participant mentioned the significance of tutoring services in providing one-on-one assistance:
>
> The tutoring services helped dust off the cobwebs from my math classes in high school. It also refreshed my memory on how to follow the steps and solve equations and word problems as I got one-one-one attention from the tutors.

This former student noted the importance of receiving one-on-one assistance from tutors and understanding step-by-step systematic process in learning mathematics.

Similarly, another survey response addressed the need for one-on-one attentions for some students in order to understand the mathematical subjects.

> The tutoring program helped me succeed because of everyday repetition and one-on-one attention, and a gradual build toward a test that was still fresh within my short and long-term memory.

Additionally, Beth noted the need for more tutoring hours outside classroom as the Math Learning Center was closed during the time program was offered and therefore, there was no tutoring available anywhere on the campus.

> When I took it over December 2014, the math lab was closed. Having tutoring outside classroom would have been very helpful. Because I could have gone over there and asked the tutors to help me with my questions… Some additional help in the afternoon, after the class, would have been helpful. Because you are in the class for a short period of time, for the certain amount of days, and you want to make the most of it. I really studied hard and I tried to be successful and just having that component would have been very helpful.

Here Beth is emphasizing the need for having access to mathematics tutoring services each day during the program as she needed more time practicing the concepts. The tutoring services provided more time for practicing daily lessons and clarifying any questions students might have.

All these statements from survey and interview participants signified the need for additional tutoring services to provide one-on-one assistance for students who need more supervised daily practice. Additionally, since the Mathematics Success program was offered during the time that the Math Learning Center was closed; the program participants have no access to any other tutoring outside the program. Therefore, the researcher categorized these responses as the need for more tutoring services and increased the tutoring hours from two hours on the last day to 8:00 am to 5:00 pm every day in the Mathematics Success program that was offered in January 2017.

Supplemental practices: Third major aspect of the program that eight out of eleven former students identified valuable and helpful was the supplemental practices that sometimes were provided during the program, which also reflected the responses to the survey questions. Supplemental practices includes daily quizzes and homework as well as the extra practice test that students take on the last day of the program before taking the mathematics placement test. Students mentioned the need for more

supplemental practices in the form of day-to-day quizzes or assignments so they can continue practicing the mathematical concepts discussed in the program after leaving the class. For this category, sample written responses to the surveys are quoted below followed by excerpts from the interview transcripts.

From the survey data students noted that significance of the supplemental practices such as take home quizzes or homework in learning mathematics and success in the program. For instance, one of the participants said: "I felt the extra notes [quizzes] helped a lot. Especially the practice test. I actually took the test and made four copies. I took each test one after the other to make sure I knew how to solve each problem." Here the student is signifying the importance of the supplemental practices and quizzes that were provided to the students in the program. The students mentioned practicing the same quiz repeatedly to make sure that he/she fully understands the material. This indicated the needs for more take home practices such as daily quizzes and assignments to provide supplemental material for those students who need more practices outside the classroom.

Another survey participant stated:

> Homework was sent home on somedays, which also reinforced the concepts. The way it was set up to learn the material in a short amount of time was excellent. The final thing that I felt was so helpful was to have a practice test before the placement test. I felt semi-confident in what I learned, but the practice test showed me areas where I made mistakes and where I needed to look at again. I also realized how to manage my time better since the placement exam was timed.

This former student benefited from the take-home homework that sometimes were provided during the program since it strengthened the concepts discussed in class. Also, the practice placement test that was taken on the last day, showed her the areas that need

improvement for the placement test such as time management and specific mathematical subjects.

In my interview with James, he stated the value of available supplemental practices in his understanding of the mathematical contents during the program. He also mentioned the need for more practice problems as he said:

> I think you provided us questions . . . homework. . . just to practice . . . I just went over those questions that you gave us. And then, I had a tutor just mark it and see what I got right and got wrong. And the one I got wrong, the tutor would show me what I did wrong. So, that helped. But I think I needed more of those practice problems.

Likewise, Molly, one of the former students who attended the Mathematics Success program twice, noted the daily quizzes and practices as one of the most important aspects of the program to help her succeed. She said:

> Daily quizzes and practices are what helped me out at the end because we'd go through them in class with the tutor. The tutor would ask students to come up to the board and show her exactly how they did each problem. This was very helpful to find out what I was missing from each problem. Then the tutor did the problems so [students] could see in what part they made mistakes, and then she asked us to try another one.
> Similarly Joe mentioned: "quizzes were helpful to make us ready for the assessment test. That way we didn't forget anything important throughout the course of the program."

These examples suggests that not only did the students practice the extra problems on their own as a form of assessment of their knowledge, but also they discussed them with the instructional staff to learn from their mistakes and attain a deeper level of comprehension.

Mike, another former student who attended the program for Intermediate Algebra level stated:

> More daily practices in any form would be helpful . . . it would be easier for the students since they would be practicing more and more and they wouldn't be as anxious for the real placement test. Yeah, that would be very helpful. I mostly finished them inside the classroom, maybe if I didn't understand something I would go home, come back, and just redo it and just go over them step by step.

He explained that the daily quizzes not only emphasized mathematics concepts, but also reduced his anxiety for taking the mathematics placement test. Similarly, Beth noted the importance of take-home homework as a reinforcing tool of learning. She said: ". . . so and then the homework was helpful because then it was different ways of giving the same material. It was reinforcing everything."

A survey participant noted the importance of the practice test that was provided on the last day of the program.

> I think the support is all there. When I attended the program, the instructor was willing to stay after class to help students and even provided extra problems to practice before the placement exam [practice test]. The extra problems helped a lot and I hope that sort of dedication could be found in all of the professors.

All these examples provided evidence of effectiveness of the supplemental practices, such as daily quizzes and homework, as well as the culminating practice test in promoting student success in the Mathematics Success program. Students found these supplemental practices helpful in their understanding of mathematics concepts as they reinforced what they learned and practiced in the classroom with the instructional staff. The daily extra practices assisted the participants to assess themselves and their understanding of the mathematical concepts at home and on their own. This would clarify if they need to study and practice more, or meet with a tutor to explain their questions. Also, the practice test given on the last day of the program allowed them to assess their

knowledge of what they have learned in the program for seven days before taking the placement test. This also helped in reducing their test anxiety and boosting their confidence. Additionally, these examples revealed the need for more practice problems on a regular bases. As a result, the researcher implemented daily quizzes and homework in the Mathematics Success program that was offered in January 2017.

Math Anxiety workshop. The fourth major facet of the program that seven out of eleven former students identified as useful and beneficial was the Math Anxiety workshop that was an optional component of the program. The participants had the option of attending the Math Anxiety workshop that was offered once during the program. Many former students who attended the workshop found it helpful to learn about study techniques and mindset techniques. Participants learned about study techniques such as how human brain learns and remembers, tips on studying mathematics, test taking tips, and study habits as well as mindset techniques such using available resources, anxiety reduction techniques, breathing techniques, and perseverance. The participants noted that not only did the workshop created additional support during the program, but also assisted them with future college-level mathematics courses after attending the program. Furthermore, students stated that all participants could benefit from the information shared in the Math Anxiety workshop regardless of their mathematical knowledge and skills since they can apply it to any other courses that they take in the future. For this category, sample written responses to the surveys are quoted below followed by excerpts from the interview transcripts.

One of the survey participants simply said: “Taking the Math Anxiety workshop has helped me understand how important tutoring and healthy study habits are.” Here the

student is referring to the useful study habits discussed in the Math Anxiety workshop. Some of these study habits include reviewing class notes before attempting homework, doing homework within 24 hours of learning the concepts, and assessing your knowledge after completing the homework assignments. Another survey participant addressed the study techniques as she said:

> The statistics course I attended after the program required the ability to comfortably navigate formulas and correctly plug data into equations. I believe my success in this course was a direct result of my experience in the Mathematics Success program and the techniques I learned in the Math Anxiety workshop.

Another survey participants noted the importance of the mindset techniques as he said:

> I learned a lot from the Math Anxiety workshop, developed a perseverance, and learned to ask for help from the professor or tutors, as well as how effectively make use of my resources within the frame of keeping concepts fresh within my head. Lastly, I slowly began to learn that asking for help, and taking advantage of every form of help that came my way was a blessing and necessity.

Here the survey participant is referring to the specific aspect of the Math Anxiety workshop that explains the academic and non-academic student resources on campus and encourages students to ask for help when needed. To do so, a student speaker shares his experience with the audience and explains how he changed his mathematics grades from an F to an A by asking for help. Many students connect and relate to the student speaker experience as noted by Joe:

> I believe I was at the Math Anxiety workshop before the program started. The two instructors had a very good impact on the whole math situation. I identify more with the second speaker than I did with the first speaker because I can identify what he said, and like "oh, math is really easy and I can knock this out like English or science or US history, so I didn't ask for help and failed my math class." It was something, I could relate to as I was watching that former student speak out about his struggle and anxiety

> with math; I felt like it really opened, you know a door, right open for someone like me to do well and do better in math. The speaker student said that he asked for help anytime he was lost and he went from lost in math to being an A student in Math . . . At least I feel as though with this program, it really helped me out tremendously . . . with my situation with math . . . Mostly with elementary algebra.

Here Joe is referring to the two instructors who facilitate the Math Anxiety workshop, one mathematics faculty and one counselor, and the impact they had on Joe's mathematics point of view as he failed the Elementary Algebra three time at the Oceanview Community College. He also mentioned the student speaker who shared his struggles in mathematics and how he gained success by asking questions and taking advantages of the available resources. Students who were struggling with mathematics and had some difficulties learning mathematics could relate with the student speaker and realize that they can achieve success as well.

From the interview data, the former students voiced the importance of the Math Anxiety workshop in their success in the program as well as the college-level courses. The students who attended the optional workshop noted they learned about proper study habit for mathematics courses, how to memorize, understand, and apply mathematics formulas, and available student resources such as the Math Learning Center and Tutoring Center. For example, Lisa stated:

> The Math Anxiety workshop was great. The peppermints were wonderful. And I loved how you told us about different student resources available to us. I also loved the test anxiety and the techniques to fight it and the whole process. It was really good, and it gave me more structure.

Here Lisa is referring to peppermints and its effect on increasing learning. One of the faculty who facilitates the workshop talks about the positive effect of peppermints on learning. She also has them in the room so the students can try them. Also, she noted the

tips on reducing test anxiety that was shared with them by a counselor during the workshop. Ted who attended the program after failing the Elementary Algebra three times, expressed that he learned from the Math Anxiety workshop to take the tests without being anxious and worrisome. He also claimed he felt more confidence in the mathematics class he took after attending the Mathematics Success program and he is proud that he understands mathematics now. Ted stated:

> When I hear math my blood-pressure goes up, I just don't like it. Personal preference, I like science, I like history, math not so much. The element that helped me succeed in my math course was confidence. I was confident that I could do my best and get the concepts. I mean tackle the test without worrying about them. That is what I did. That's what I learned from the workshop… I hated math, but I can do it. I can do it, so it's a pride for me now because the feeling I had towards math is not strong, you know, it's an acquired taste something like that . . . You know.

James, another former student who experienced multiple failures in his mathematics classes in high school said:

> I believe that all the elements of the program helped. Just because it got me to the next step, it got me to be able to get into the next math class and actually understand it. . . . The thing that helped me the most, I feel, like the anxiety part . . . Before any math test . . . I get like, I get sweaty, I get . . . You know, my heart racing . . . my stomach feels like it's in a knot . . . So, a lot of the things that you taught us . . . breathing . . . making sure that your feet are planted. Breathe in, breathe out . . . it slows your heart rate down and gets your blood flowing normally so you can feel comfortable. I think that honestly helped me the most, but not just the math test, with all classes, with all tests.

Here James is referring to the breathing techniques to reduce anxiety that participants get to practice with a counselor during the Math Anxiety workshop. A counselor demonstrates the breathing techniques in front of the room and students practice it with him. James expressed that he found the breathing techniques to transfer to

other subjects, meaning it reduced his math anxiety and improved his general experience taking tests.

Another former student, Molly, who attended the Mathematics Success program twice said:

> I learned from the Math Anxiety workshop to get the help I need. Before attending the workshop, I was a little embarrassed to ask for help. Not embarrassed, but more like I thought I can do this, I don't need any help. Even with the statistics class, there were somethings that I needed help with and I was asking professors if there is any way I can get some feedback. This program made me understand it's OK to ask for help. In the Math Anxiety workshop we learned about many different programs available to help us because they want us to succeed. So that was why I said that no matter what, I am going to get help with tutoring and use the other programs.

Molly noted that before attending Math Anxiety workshop, she preferred not asking any questions from her professors or tutors, however after attending the workshop she not only learned about different programs available for students, she started asking questions and requesting feedback from her professors. She also mentioned that she met with tutors and asked for help in the Statistics college-level course that she took after completing Mathematics Success program. This reveals that the study habit she learned in the Math Anxiety workshop was also carried to the college-level mathematics that she took after completing the program.

In a similar vein, Mike mentioned:

> The workshop helped me to take it step-by-step, know that I was going get there, and not give up on the program. Just keep on going and reach out for help. You told us about a lot of opportunities in the Math Learning Center. I went there and they helped me out a lot with the problems I had and showed me to just keep going and practicing here and there with Math.

Here Mike talked about the mindset techniques such as asking for help that he learned about in the Math Anxiety workshop. He also met with the mathematics tutors in the Math Learning Center when he needed assistance in his college-level mathematics class and received the support he needed to be successful.

All these examples provided evidence that the Math Anxiety workshop was beneficial to many participants in the Mathematics Success program. Many former students who attended the workshop learned about many different helpful concepts such as how human brain learns and remembers, tips on studying mathematics, study habits, anxiety reduce techniques, and test taking tips. The participants noted that what they learned from the workshop helped them in the Mathematics Success program as well as the college-level mathematics courses they took after completing the program. Furthermore, most students stated that all participants could benefit from the information shared in the Math Anxiety workshop and the learned skills can be apply to any other courses that they take in the future. As a result, the researcher added the Math Anxiety workshop to the orientation session as the mandatory component of the program that was offered in January 2017. All participants attended a two-hour Math Anxiety workshop on the orientation session, one day prior to the instructional part of the program, so they can apply and practice what they learned from the workshop during the Mathematics Success program, and to any college-level course that they take in the future.

Implementation of Interventions

After studying and analyzing the former student surveys and interviews, the researcher implemented four interventions in the Mathematics Success program that was offered in January 2017. First, she added at least one more tutor to each classroom during

the January session. Students benefited from two to three tutors available in the classroom every day during the program. All tutors attended a two-hour training offered by the researcher to enhance the tutors' skills and to increase the quality of tutoring offered in the program.

Next, the researcher provided additional tutoring opportunities and increased the tutoring hours outside classroom to nine hours every day, 8:00 am to 5:00 pm, in the Mathematics Success program that was offered in January 2017. This was particularly beneficial to the students since during the time that the Mathematics Success program is offered the Math Learning Center is closed and the program participants have no access to tutoring outside the program.

Third, the researcher added the supplemental practices such as daily homework and quizzes to the January 2017 session of the Mathematics Success program. The daily homework and quizzes were provided by the researcher to the students. The hard copy of the daily supplemental practices were delivered to the instructional staff and were distributed to the students. The final answers to the problems were also provided so the students could see if they solved the problems correctly. These were reinforcement-learning tools that the majority of the students found them helpful in their understanding of mathematics concepts as they practiced them at home or in the classroom with the instructional staff. Also, the researcher devoted the last day of the program to giving a practice test so the participants so they could assess their knowledge and skills of what they have learned in the program before taking the placement test. This also helped in reducing their test anxiety and boosting their confidence.

Finally, the researcher implemented a two-hour mandatory Math Anxiety workshop into the orientation session of the Mathematics Success program that was offered in January 2017. All participants attended the Math Anxiety workshop one day prior to the start of the program, topics discussed included the science behind learning and memory strategies, tips on studying mathematics, study habits, anxiety reducing techniques, and test taking tips.

Additionally, the researcher provided a two-hour mandatory professional development for all instructional staff including the instructors and tutors who participated in the January session. This intervention was implemented since some of the former students noted different teaching methods and strategies used by different instructors in the program. For example, Fred, one of the former students who is going to be an elementary teacher mentioned:

> So the problem I'm seeing with a lot of teachers is that they are assuming that I should know certain stuff. Not taking into consideration that in a Community College, people come from different time frames and academic background. Some people just came out of high school, some people have been out of high school for years, some people have been in college for years, but some teachers assume everybody knows everything. But the template I saw in the program from you was how I need to break down every problem. That's what I use when I encounter math. Now the problem is that some teachers in the program don't teach the way you do, so that's the problem. They're not breaking it down the way you do, which was very helpful to me. That's something I took away from your math class, your Mathematics Success program, how you broke everything down and that's what I think I'm going to do when I teach in the future. I'm not going to be the type of teacher who assumes you know all of this and just give you D.

Fred noted that he benefited from the systematic step-by-step approach and he will practice this technique when he will be a teacher. He also noted that some instructors assume that all students have some prior Mathematical knowledge regardless of the open

door policy of California Community Colleges. He emphasized that community college students come from different academic backgrounds and all faculty need to be informed and sensitive to the diversity of prior knowledge. The researcher discussed this topic with all instructional staff during the mandatory training and reminded everyone about the student-centered approach in the Mathematics Success program. The researcher also presented how to explain different mathematics topics with a systematic step-by-step approach during the training. This was followed by a group discussion about the benefits of this technique.

The aforementioned interventions convey how the design-based research methodology has guided the second phase of this research. The data pointed to specific areas of importance and improvement, and like most DBR, this study takes place within a tangible learning environment and pulls from a multitude of data sources to determine appropriate interventions (Anderson & Shattuck, 2012). The researcher deliberately identified multiple points of intervention in order to engage in a complex implementation of DBR and avoid the vulnerability of relying upon a single intervention (Zheng, 2015).

Phase Two Findings: Results of the Interventions

Quantitative Results: Prior to the program changes, in summer 2016, 93% of the participants were successfully placed into a higher mathematics class after attending and completing the Mathematics Success program. The success rate after the implementation of the interventions reached a new high score of 97% which is statistically significant comparing to the summer 2016 success rate. This significant change implies that the interventions were effective and most helpful to the participants in January 2017 session.

To strengthen this claim, a paired-samples t-test was conducted to evaluate the impact of the Mathematics Success program on students' scores on the placement test in 2017. There was statistically significant increase (*P-value* < 0.001, as shown in Table 6) in the students' placement test scores from pre-assessment to the post-assessment as shown in Table 5 which indicates the effectiveness of the Mathematics Success program for all students. The eta-squared statistic (0.63) indicated a large effect size.

Table 5. Descriptive Statistics for Pre and Post-Placement Scores

	Mean	Standard Deviation	Standard Error Mean
Pre-Assessment	45.624%	24.18781%	6.04695%
Post-Assessment	72.9688%	15.40092%	3.85023%

Table 6. Paired Samples T-Test Statistics

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Standard Deviation	Standard Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pre- & Post-Assess	-27.3437%	21.29799%	5.3245%	-38.693%	-15.99485%	-5.135	15	.000

Next the researcher examined to see how much of the variance in the change in the students' scores on the placement test is explained by gender, ethnicity, and previous mathematical skills. A one-way ANOVA was conducted to compare learning gains between the five ethnicity groups (Group 1: ASIAN, Group 2: BLACK, Group 3: FILIPINO, Group 4: HISPANIC, Group 5: OTHER, GROUP 6: WHITE). The means and standard deviations are presented in Table 7. The results indicate that there was no

significant difference between the learning gains of different ethnicity groups (*F(5,46)=1.502, p=0.208>>0.05).*

Table 7. Descriptive Statistics for Learning Gains for Different Ethnicity Group

Ethnicity Group	Mean	Std. Deviation	Std. Error
1: Asian	76.4336%	.	.
2: African-American	38.0158%	36.94238%	15.08166%
3: Filipino	69.2308%	.	.
4: Hispanic	29.3473%	30.67344%	6.69349%
5: Other	13.8513%	45.23873%	22.61936%
6: White	46.5071%	29.18889%	6.69639%
Total	37.0979%	32.78165%	4.54600%

The researcher also examined the learning gains between different genders. An independent-samples t-test was conducted to compare the learning gains for students who identified as males (Group 2) and students who identified as females (Group 1). As seen in the table 8 below, there was no significant difference in learning gains for males and females (*t(50)=-0.894, p=0.376>>0.05).*

Table 8. Descriptive Statistics for Learning Gains for Different Genders

Gender	Mean	Std. Deviation	Std. Error Mean
1: Female	34.6274%	31.99940%	5.19099%
2: Male	43.8036%	35.14635%	9.39326%

As a result of these tests, the researcher can conclude that gender and ethnicity are not good predictors of students learning gains.

One way ANOVA was also conducted to compare the learning gains among students with different mathematical backgrounds (Group 1: 1-2 years since last math class, Group 2: 3-5 years since last math class, Group 3: Currently in a math class, Group 4: less than a year since last math class, Group 5: more than five years since last math

class). There was no statistically significant difference in learning gains among the given groups (*F(4, 47)=1.271, p=0.295>>0.05)*. The table 9 shows the descriptive statistics for five groups with different times since their last math class.

Table 9. Descriptive Statistics for Learning Gains of Students with different mathematical background.

	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
1	56.0931%	24.19791%	7.65205%	38.7829%	73.4032%
2	34.9531%	42.44266%	17.32714%	-9.5877%	79.4940%
3	3.9039%	.	.	.	.
4	31.9558%	30.35773%	8.76352%	12.6674%	51.2442%
5	33.5247%	33.73942%	7.03516%	18.9347%	48.1148%
Total	37.0979%	32.78165%	4.54600%	27.9715%	46.2244%

The quantitative results of this study show that there is no relation between the time since the last mathematics class and students' scores on the post-assessment. Also, there is a strong positive relationship between the post-assessment scores and pre-assessment results. The researcher did not find any correlation among the ethnicity, gender and the post-assessment scores. All these findings attest to the efficiency of the program in assisting all students regardless of their ethnicity, gender, and the time since their last mathematics class.

Qualitative results. In phase one of data collection, the researcher surveyed and interviewed eleven former students. The analysis of the phase one data helped the researcher to get initial findings for the first two research questions. She also implemented four interventions based on the phase one data collection and analysis. These four interventions included adding more classroom tutors, providing nine hours of

tutoring services, giving supplemental practices, and adding the mandatory two-hour Math Anxiety workshop.

In phase two of the study, fifteen students representing different genders and ethnicities who attended the program in January 2017 as well as all 14 instructional staff were surveyed and interviewed. These surveys and interviews helped the researcher to assess the interventions that were implemented in January 2017 session of the Mathematics Success program. Additionally, phase two allowed the researcher to collect relevant data for all of the research questions.

Similar to the former students, the participants who attended the program after implementing four interventions in January 2017 noted classroom tutors, the Math Anxiety workshop, tutoring services, and supplemental practices as the most helpful and effective aspects of the Mathematics Success program. Since the researcher used grounded theory in creating categories based on survey and interview responses, she included sample responses form the surveys and interviews from the second phase of the study.

Classroom Tutors. One major aspect of the program that all fifteen current students identified as effective and helpful in taking the mathematics placement test was the availability of two or three tutors in the classrooms, which also reflected the responses to the survey questions. All fifteen current students noted that the classroom tutors provided instant assistance to them if they did not understand a concept, walked students through the process, and helped them so they could continue with the rest of class. They also mentioned since there were two or three tutors available in class, there was no waiting time to get their questions answered. For this category, sample written

responses to the surveys are quoted below followed by excerpts from the interview transcripts.

From the survey data the majority of the participants who attended the Mathematics Success program in January 2017 noted the significance of the classroom tutors in their success. One of the participants simply said: “I really liked how there were two tutors in the room. That way we were able to have one-on-one help if needed.” Another participant said: “The two tutors in the classroom were the best helpful things for me.” Similarly, another survey participants stated:

> The instructor and instructor aides were so valuable. No questions went unanswered, and they all worked very hard to make sure nobody in the class was falling behind. If I didn't get something, they would work with me using all kinds of different explanations until I understood. I know that most of us in the class have never received that kind of attention and help while learning math, so it was extremely helpful.

Here the student communicated about the support provided by the tutors in the classroom so students’ questions were answered with different explanations so no one fell behind. This survey participant also mentioned that he never received this kind of attention before in an academic setting so he felt important due to the thoughtful and considerate caring received from the instructional staff.

Another student mentioned: “The tutors in class were phenomenal.” All the survey data were confirming the effectiveness of the additional tutors in classroom as they provided immediate assistance to the students. Also, since there were two or three tutors available in every classroom, there was almost no wait time for the students to get their questions answered.

From the interview data, the current students voiced the importance of additional classroom tutors. Sean who was a returning student attending Oceanview Community College after many years said: “I love the aides in there because it allowed for the one-on-one help if you need it. You know, I’m not a spring chicken anymore…if I don’t get it, I raise my hand and ask for help.” Similarly, Jose said: “Whenever I felt like I was in an uncomfortable position with math, I would call one over.”

Alex, an international student from Africa, who was recently admitted to the Oceanview Community College and attended the Mathematics Success program, talked about the aspects of the program that helped him succeed in the mathematics placement test:

> I think there are a lot of factors. There is the instructors and tutors were really open to the students and really devoted. The instructional staff were really devoted. They showed that they not only want you to understand, but they want you to get better in math and that’s really important because that’s what I felt gave me a positive influence . . . and that’s really important when someone wants to learn math. So it’s really important. I remembered that in Africa, in my . . . high school . . . my math teachers were so serious . . . and the difference that I got here was that the instructors were really devoted and kind. They tried to be more friendly.

Here Alex mentioned the care and devotion he felt and received from the instructors and tutors and he found it important in his learning mathematics. He felt that the instructional staff wanted him to learn and understand mathematics, which is an affirmation that the training provided for the instructional staff was helpful and effective. Alex successfully passed the Intermediate Algebra placement test at the end of the program and enrolled into a college-level mathematics class.

Scott, another returning student to the Oceanview Community College stated his point of view about the classroom tutors:

> I used the in class tutoring. If I got a problem wrong, she came by and helped me. She showed me exactly how to do it. She helped me a lot. Two extra tutors were really helpful because they made sure everyone understood everything. Like if we put a problem on the board and if we got it wrong, they showed us the answer and the steps to get to the answer.

Here Scott talked about the different ways that he utilized the two tutors in the classroom. He used the tutors to get one-on-one assistance during the class if he needed a clarification as well as during the review when they worked on specific problems and asked the tutors to check his work and to provide feedback for him. He mentioned the tutors in the classroom as the most important factor in his success in the program.

Another current student, Tony, who had several failure experiences with his mathematics classes at Oceanview Community College talked about using the classroom tutors:

> During the class period, if I got stuck, the professorthat was teaching would not hesitate to stay on that question and go more over in depth. One of the biggest problem that I had with the math 64 course that I took before coming to this program was that we moved too fast for my understanding. We wouldn't have enough time to go into deep detail on a certain question. I just couldn't understand it. So I felt that I just had to catch up, and even though this program was a lot shorter in time as compared to that class, it still seemed like it was enough for me to learn . . . In the program, I had the tutor go over things in depth with me when I felt like I was stuck. And then she would also help me out with the present problems . . . so we would be working on the problem that I was stuck on as well as the problem we were learning as a class.

Here Tony referred to one of the reasons for his past failure in the Intermediate Algebra course which he felt the instructor was moving too quickly as he did not understand the concepts covered and therefore, he felt behind in that course and ultimately failed the course. He mentioned that even though the Mathematics Success program was offered in a shorter time as compared with his Intermediate Algebra class,

he felt he understood the mathematical subjects covered with the help of the tutors in the classroom. He utilized them not only to comprehend any concept he did not understand, but also for the present problem that everyone was working on.

Likewise, Susan talked about the importance of classroom tutors as she stated:

> Having the tutors there was awesome. We were all kind of doing the practice problems and every time there would be a student that would get something wrong, or her answer didn't match up with the rest of the class, immediately the tutors were there to help. They helped me greatly and they would explain it in a way that it got me right back on track with the rest of the class.

Susan mentioned that she and other students utilized the tutors available in classroom to understand the concepts so they can move on to the next problem. She also mentioned that the tutors explained the concept to her in a way that was easy to understand so she could continue with class. This is another affirmation that the training provided for tutors was effective and beneficial to the students who attended the program in January 2017.

Ana who graduated from high school prior to attending the Mathematics Success program explained that she used the tutors whenever she was stuck on a problem and expressed that they were very helpful for her in the program. She said:

> I used the tutors to ask questions when I got stuck on problems. Maybe the instructor and class will continue reviewing the next problem, but the tutor made sure that I understood what I needed to do and that was great. I used the tutors that were in the classroom a lot and they were super helpful.

Jeana who attended the Mathematics Success program twice described the importance of having two tutors in classroom as compared to having one tutor when she attended the program in the past. She said:

> Well, this time there were two tutors instead of one and that helped a lot because there was no waiting if I had a question. Because the first time I

> took it, if I had a question and the tutor was helping someone else then I had to wait and maybe they moved on to help another person or sometimes I forgot my question. So, it was nice to have two tutors in our classroom.

Jeana's statement is another confirmation that additional classroom tutors were beneficial to the participants as it cut down the waiting time to get their questions answered. All these examples confirmed that the additional tutors in classroom were effective for the many participants in the Mathematics Success program in January 2017. The compilation of these statements from survey and interview participants signified that additional tutors in the classroom was a successful intervention.

Math Anxiety workshop. The second major aspect of the program that all fifteen current students identified as effective and helpful in taking the mathematics placement test was attending the Math Anxiety workshop during the orientation, which also reflected the responses to the survey questions. All fifteen current students noted that the Math Anxiety workshop provided them with a set of skills and knowledge that helped them during the program and in taking the mathematics placement test. The current students who attended the workshop noted that they learned about study skills such as how human brain learns and remembers, tips on studying mathematics, study habits, anxiety reduce techniques, and test taking tips. They also noted that what they learned from the workshop can be applied to other college-level courses they will take in the future.

From the survey data the majority of the participants who attended the Mathematics Success program in January 2017 noted the significance of the Math Anxiety workshop in their success. One of the survey participants simply said: "I will

definitely take a lot of the study habits that I learned from the workshop with me to higher-level classes I take in the future. I will also ask for help more when needed." Another participant stated: "The Math Anxiety Workshop taught me about all the resources available to me on campus. That will be very helpful as I move forward to college transferable classes." Similarly, another survey participants explained how the Math Anxiety workshop helped this student to be more accountable:

> The workshop helped me in several areas in my math studies. I struggled with procrastination and was unable to stay focused for class or homework, and this workshop helped me fall into a good rhythm to stay accountable. Because of this, I was able to understand the concepts and keep up with the class in ways I've never been capable of before.

Likewise another student said:

> I'm now able to hold myself accountable with homework and studying, which helps me retain the information better than I've ever been able to. And because of this, I'll be able to excel in my future math courses and not fall behind like I often did before.

Here these students are referring to a counseling segment of the workshop that focuses on avoiding procrastination and negative thoughts while providing tools to combat these tendencies.

Another participant talked about the science behind learning that is discussed during the Math Anxiety workshop and explains why any human being needs to practice in order to learn, how dendrites work, and how long will take for human beings to grow them. The participant said: "The talk about dendrites actually helped me a lot because I was never really that great at math. I practiced a lot to grow dendrites and learned how to take better notes." Similarly, another student said: "The knowledge about dendrites and how the brain obtains knowledge was fascinating." Some other students noted the skills

and the study techniques they learned in the workshop. For example one survey participant wrote:

> I learned how studying math actually works. I never saw math as a "skill" that had to be practiced and built up. I would just expect to retain and understand everything from class, and would be frustrated when that wasn't the case. The Math Anxiety workshop helped me learn new study techniques.

Here the student is referring to the science behind learning that describes how our brain learns and remembers. She also mentioned learning about study techniques that are explained during the workshop such as study cycle, mnemonic techniques, and creating formula sheets.

Another student described he always struggled with mathematics and how the Math Anxiety workshop helped to learn about skills and tools to overcome his anxiety.

> Before the Mathematics Success program, I had little to no success in my math courses. I took all of my courses online and had a lot of anxiety when I went in to take my tests. This program helped me overcome my math anxiety and I learned that taking face-to-face courses is beneficial for me. I've had problems with math all my life, a feeling of inadequacy, however this program encouraged me to take what I've learned and taught me how to apply it properly.

From the interview data, the current students voiced the importance of the Math Anxiety workshop in their success in the program as well as college-level courses. All fifteen current students who were interviewed noted they learned about proper study habit for mathematics courses, how to memorize, understand, and apply mathematics formulas, and available student resources such as the Math Learning Center and Tutoring Center. For example, Angela stated:

“They talked in the orientation about growing dendrites and learning and the importance of repetition and practicing helped me to keep that fresh in my mind and pass the big

test." Furthermore, another student, Lori, who attended the Math Anxiety workshop twice talked about her math anxiety and learning disability as she said:

> Math Anxiety was Fantastic! It really is good, and I do have tremendous amount of math anxiety and a learning disability surrounding that . . . I really enjoyed the way that workshop was presented this time with a student speaker. I've taken it before with you. And this time it was excellent and it was even more powerful and just right on point. I learned a lot about test anxiety and the techniques to have it under control.

Keith who recently graduated from high school and according to him he disliked mathematics before attending the program said:

> The Math Anxiety workshop helped me with time management because at college, I still have homework to do even not for a grade, but I still want to get it done. So it helped me and taught me to put time away for homework and study. Because I work, I did four hours of math class, and went to work and then got the homework done, and then did the quizzes, studied for the quizzes and . . . managed my time much better.

Here Keith referring to the study skills and time management that was discussed during the Math Anxiety workshop and he found it helpful to balance work and school. Scott explained that by attending the Math Anxiety workshop he learned about advantages of using tutoring services. He said:

> I went to the Math Anxiety seminar and the thing that helped me the most was learning about the tutoring services, after school or after the class, to do my homework there. Before coming to the Math Anxiety workshop, I didn't ever really use tutoring services other than for computer science. I thought if I just applied myself, I will succeed. Because before I thought I just wasn't smart enough for this because I didn't understand math, but now, I realize that if I just put my head into it, I can do it. It was just like putting more power through my brain and I'll be able to do it. I feel a lot more confident now. I took algebra II twice and failed, and this has been the most helpful thing.

Here Scott is referring to the aspect of the Math Anxiety workshop that shares the different available student resources, academic and non-academic, with the students. One

of these resources is tutoring services available for the students. Scott also mentioned that he started using the tutoring services during the program and found it very beneficial for learning mathematics. Similarly, Ana mentioned: "I learn that we have a math learning center, I learned that we have an online tutoring too, we have the Mathematics success program, and many more. We have plenty of resources." Then Ana continued:

> Back in high school I was afraid of math. I had all these fears about math . . . I remember that I always got a headache. After the workshop I learned that I have to practice, I got more confidence and now I think I got even more skills than I even thought I ever had, so it's good . . . I don't know how, but this program works. I practiced a lot with the tutors.

Ana learned that by practicing she can overcome her fear and anxiety of math and change that fear to confidence and success. Jackie, a recent high school graduate who would like to study Science, said:

> I learned many good tips from the workshop. Being able to practice within 15 minutes after learning something is going to become part of my daily study regimen, knowing that I can apply that knowledge not only to math, but to my other subjects as well. And I'll go to the Math Learning Center every day when I take college-level math classes.

Here Jackie is referring to the study skills and study cycle discussed in the Math Anxiety workshop. For example, students learn to study and do homework immediately after learning a concept to retain more information. Also she refers to going to the Math Learning Center, which is one of the resources available to the students at the Oceanview Community College. Likewise, Jeana who attended the Mathematics Success program twice said:

> Taking the anxiety workshop and then learning about all of the resources that are available made me feel confident that when I am in a college-level class, if I have any issues, I can go to the Math Learning Center or make an appointment with tutors. I know that I'm probably not be going to be amazing in the class, but I know that I have plenty of help at my disposal.

> I always looked at math, especially when I was in high school, of something that I wasn't good at… I just couldn't do it . . . I have so much confidence after attending the workshop. It's not just that I feel I could do math . . . I feel confident in myself that I can do it and I can be successful. And . . . so, it gave me confidence to know that if I really applied myself, then I can . . . can really do anything.

Jeana explained that not only she learned about student resources in the Math Anxiety workshop, but also she has a high confidence in herself that she can do anything, and she can achieve success in college courses by using the student resources.

All these examples confirmed that the Math Anxiety workshop was effective and helpful to many participants in the Mathematics Success program in January 2017. All these statements from survey and interview participants signified that the Math Anxiety workshop provided the participants many practical and valuable knowledge such as study skills, science behind learning, understanding and applying mathematics formulas, managing and reducing anxiety, breathing techniques, and available student resources such as the Math Learning Center and Tutoring Center. Students applied these skills during the Mathematics Success program and furthermore are able to apply this knowledge throughout their college coursework

Tutoring services. Another major aspect of the program that twelve out of fifteen current students identified as effective and valuable in their success in the program was tutoring services, which also reflected the responses to the survey questions. Twelve current students noted that the tutors had a deep understanding of mathematical concepts, homework and quiz problems, and if they missed a day they could meet with the tutors before or after class to catch up. Students mentioned the need for more tutoring hours outside the classroom so students can continue practicing and learning the mathematical

contents under the supervision of tutors, getting one-on-one help when needed, and spending more time practicing the concepts. The tutoring services were available from 8:00 a.m. to 5:00 p.m. every day during the program. This was the only way students could receive extra assistance if needed since the Tutoring Center and the Math Learning Center were closed during the Mathematic Success program. Sample written responses to the surveys are quoted below followed by excerpts from the interview transcripts.

From the survey data the majority of the participants who attended the Mathematics Success program in January 2017 noted the significance of the additional tutoring in their success. One of the survey participants simply said: "The one-on-one tutor time, as well as the tricks and tips instructors gave to help the students were the best parts. The tutors were very friendly." Another participant stated: "The tutors were great, I loved that there was a tutoring session every day in case we needed help." Similarly, another student said: "The tutors in the tutoring room were very receptive. I did my daily homework in the tutoring room and if they saw that I was struggling or if I have an issue, they were right on it. And they came right over immediately and helped." Here the student explained that she felt comfortable to complete her daily homework at the tutoring room as the tutors provided any explanation or extra help needed.

Likewise, from the interview data, the current students voiced the importance of the afterhours tutoring in their success in the program. Twelve current students who were interviewed named tutoring services as one of the most valuable aspect of the program. For example, Angela explained how she utilized this resource to achieve success. She said:

> Sometimes, when I'm at home and I'm trying to do the work, I sort of forget the next step. So it's good to have somebody there to help . . . not to tell you the next step, but lead you in that right direction. Also, one day, I was sick and I missed a day, which I know is not good habit . . . (giggle), but . . . I was able to come back. I went to the afterschool tutoring and they helped me to go over the concepts that I missed, so, that when I came in the next day, I was able to move on with the class.

Angela mentioned that not only she used the tutoring services to complete her supplemental practices, but also she was able to catch up with the rest of class after missing one day of instruction. Alex who is an international student recently joined the Oceanview Community College said:

> I used the tutoring . . . which is there for us. Most people don't know that it's really useful, and some folks don't use that resources. And I recommend to go over to the tutoring services and get help. Personally, when I take a college math class, I will go to the tutoring because they're really helpful. They're there for us . . . to help us.

Alex not only used the tutoring services, but also he recommended it to other students. Also, he said that he will go to the Tutoring Center when he takes a college-level mathematics in order to get extra help.

Likewise Maria explained how she utilized the tutoring center during the program as she shared some of her experiences at the tutoring room:

> I would say that the tutoring was amazing. I was talking to one of the tutors . . . my eyes became watery because I told her I don't feel smart enough to be in a math class and sometimes, I don't get it, but she really gave me so much support and she said: "everybody learns differently. Let me show you something that I learned." So it was funny because I actually learned more the way she taught me. And I would think that was the most supportive thing for me, as she was telling me that I have to have confident in myself. She said: "I know you can do it, the only thing is that you need to believe in yourself now." So it was the moment that I really got the support that I needed. I told myself that I can do this and I can pass this math. I was surprised that even though I was so weak in math, she was supporting me and teaching me. That really boosted my confidence and I

> would say that she changed me. She helped me . . . she was caring and supporting. I really liked going to the tutoring after my class and getting more help because I needed a lot of help.

Here Maria explained how one of the tutors helped her not only academically, but also to boosted her confidence and self-efficacy. Maria successfully passed the mathematics placement test after completing the program and she was placed into a college-level mathematic class. Similarly, Teresa found the tutoring services to be a valuable resource. She noted: "Tutoring outside the class helped me out a lot with things I needed help with. If I had a question, I would just go there and they will help me."

These examples confirmed that the tutoring services provided support for the students who needed extra help to understand the concepts. All of the participants who attended the Mathematics Success program in January 2017 session had access to tutors from 8:00 a.m. to 5:00 p.m. every day. All these statements from surveys and interviews data signified the importance of the tutoring before and after classes as well as the training that was provided for all instructional staff to increase the quality of their work. Many participants praised the level of attention and caring they received from the tutors in the program.

Supplemental practices. Another aspect of the program that twelve out of fifteen current students identified valuable and helpful was the supplemental practices that were provided on a daily basis during the program, which also reflected the responses to the survey questions. Supplemental practices included daily quizzes and homework as well as the extra practice test that students take on the last day of the program before taking the mathematics placement test. Students described that the supplemental practices in the form of day-to-day quizzes or assignments helped them to continue practicing the

mathematical concepts discussed in the program after leaving the class. The advantages of supplemental practices were discussed during the Math Anxiety workshop and student were informed about the benefits of doing homework every day including high level of retention. Sample written responses to the surveys are quoted below followed by excerpts from the interview transcripts.

From the survey data some students noted that benefits of the supplemental practices such as take home quizzes or homework in learning mathematics and success in the program. Many students simply named the daily extra practices as one of the most helpful aspect of the program. For instance, one of the participants said:

> I think the worksheets that they gave us every day were super helpful. I was sick one day and missed the class. When I came in the next day, I was able to get the practice sheet and practice it on my own. I asked a couple of questions from our tutors and I was able to move on with the rest of class. I liked having the worksheets as more support.

Here the student described the supplemental practices as a tool that not only helped her to practice every day, but also allowed her to catch up with the class after missing class one day. Another survey participant said: “The quizzes were definitely helpful because it was in the format of the test, multiple choices.” Similarly, another participant noted: “I always did the worksheets and I marked the one that I got wrong, I took it the next day and asked the tutor.” Additionally, another student stated: “The practice quizzes we got home was helpful to see if I was able to do them and how long it was taking me to solve the problem.” These survey responses provided affirmation about the effectiveness of the daily supplemental practices for the students in the program by providing multiple-choice problems, which are in the same format as the mathematics placement test.

Likewise, from the interview data, the current students voiced the importance of the supplemental practices provided, such as daily homework and quizzes, as well as the practice placement test on the last day of the program in their success in the program. Twelve current students who were interviewed named the supplemental practices as one of the most valuable aspect of the program. For example, Angela found the practice placement test given on the last day of the program very valuable as she said: "The tutors and instructors in there were able to help me brush up on everything before the test. I took the practice placement test and they reviewed what I did wrong in my practice test. It was very helpful." Here Angela is referring to the practice placement test that all the participants take on the last day of the program as a comprehensive review of what they have learned in the program. This practice test is also timed so the students learn and practice to manage their time efficiently.

Sean, one of the returning students, explained his point of view on the extra practice sheet that were distributed daily as he said:

> The extra quizzes were really good. I love the fact that the handouts had the answers on them, so we could check our final answers. If I did it and got it correctly like, "awesome!" And if I didn't get it like, "Aww man, I did it wrong…" you know… "I got the wrong answer…" If I had any questions about them, tutors actually showed us how to break those down to get to that final answer. I did most of it at home. They handed them out at the very end of the class . . . with the handout which was like a homework exercise which I did that first and then I did the quizzes. And . . . … it worked out . . . It worked out great . . . especially the quizzes. Quizzes were also something special because sometimes after practicing I wanted to assess myself, so I used the quizzes.

Here Sean is referring to the daily homework and quizzes that were handed out at the end of each session. He mentioned that he practiced the daily homework first and then in order to assess his knowledge, he took the daily quizzes. Also, if he had any

difficulties getting the correct answer that was provided on the answer sheet, he would ask the tutors for clarification. Knowledge assessment after studying and completing homework is one of the study skills that is discussed during the Math Anxiety workshop. Students are encouraged to assess what they have learned after completing homework by working on a couple of assignments on their own. Many of the Mathematics Success program exercised this technique during the program.

Likewise, Alex, an international student who recently came from Africa expressed his views on the supplemental practices as he said:

> At the end of each class, we were given the practice sheets . . . We had the . . . homework . . . for practicing at home . . . And there were more than ten questions, and that was really good because learning mathematics requires practicing, a lot of practicing. They were helpful practices and they gave me the confidence of learning the math we discussed on that specific day. I love that the answers were there so I could see if I got them right.

Alex explained that not only he used the daily homework and quizzes for practicing the concepts, but also to boost his confidence that he completely comprehended the mathematical concepts. Another student, Lori said:

> The extra practices were Wonderful! I think they were great! They really helped me to practice more and to assess my knowledge. They helped to stay on point. We didn't feel or I didn't felt, personally, pressured into doing it. But I felt obligated to do them because it would help.

Lori mentioned that even though the students did not receive any grade for doing the daily practices, she still completed them since they were helping her in learning mathematics. Similarly, Kathy found the supplemental practices useful in her success as she noted: "Daily homework is helpful. I like how we took it home, and we had a couple

of hours to forget about it and go back and see what we remembered and I think I did pretty well on them."

Here Lori mentioned that she used the worksheet as extra practice as well as an assessment tool to evaluate how much she learned and remembered from the daily mathematical discussions in the classroom. Another student, Scott referred to what he learned in the Math Anxiety workshop about practicing a concept immediately after learning it as he said:

> I think the worksheets were really helpful. I think it made me remember things because . . . based on the Math Anxiety workshop, we forget what we learn if we don't study them in 24 hours. We forget a certain amount as time passes. So . . . if we get the homework, we'll never forget it . . . because we'll be consciously doing the homework and we'll grow dendrites. We have to grow dendrites.

Similarly, Tony found the daily supplemental practices very helpful in learning mathematics as he said:

> Daily homework was definitely a big help. I think that it was something to force me to study after class . . . I probably wouldn't study after four hours of math class if there was no homework. Even though there was no grade for homework, I still took the time to do them for growing dendrites. I think the quizzes and homework were really effective. I learned that having quizzes or daily homework . . . definitely help. So even if homework was not assigned, I made some problems and I practiced them.

Tony explained that the supplemental practice sheet helped him to continue practicing the concepts that he learned for four hours in the class. He also referred to the Math Anxiety workshop by mentioning "growing dendrites" which happens when learning take places. Similarly, Susan referred to the Math Anxiety workshop and how the supplemental practices helped her to grow dendrites which indicates learning the concepts. Susan said: "I think extra practices are perfect additions to the class. I feel like that really helped to grow the dendrites and really helped me to excel learning processes."

Finally, Jeana who attended the Mathematics Success program twice explained the differences she noticed in the second program:

> I mean the things that I thought are needed after I took the program the first time, you guys already fixed . . . so I think that the program is pretty great now. You know, more tutors and more opportunities to go to tutoring and the homework and quizzes in class helped a lot . . . I think my biggest problem the first time I took it [the mathematics placement test] was realizing how long it was taking me to solve problems . . . I couldn't finish it on time. So this time, by doing the worksheets, I learned how to manage my time better and I was more successful.

All these examples provided evidence of effectiveness of the supplemental practices such as daily quizzes and homework and the practice test in student success in the Mathematics Success program. Students found these daily supplemental practices helpful in their understanding of mathematics concepts as they reinforced what they learned and practiced in the classroom. The multiple-choice supplemental practices helped the participants to assess their knowledge of the mathematical concepts at home and on their own. This would help them to realize if they need to study and practice more, or meet with a tutor to clarify their questions. Also, the practice test given on the last day of the program helped them to assess their knowledge of what they have learned in the program for seven days before taking the placement test. This also helped in reducing their test anxiety and boosting their confidence.

Instructional staff. In phase two of data collection, the researcher surveyed and interviewed all fourteen instructional staff representing different genders and ethnicities. All instructional staff identified *classroom tutors, tutoring services, and the supplemental practices* as most beneficial aspects of the Mathematics Success program. Some of the instructional staff who have been with the program for about two years noticed the effectiveness of the new interventions on student success in the program. Since the

researcher used grounded theory in creating categories based on survey and interview responses, she included sample responses form the surveys and interviews with the entire instructional staff team

Classroom Tutors. In addition to the former and current students, all instructional staff identified the classroom tutors as one of the most important and valuable aspects of the program that helped students succeed in the mathematics placement test. This was a moment of triangulation in the data that all survey participants and interviewees identified classroom tutors as the most valuable aspect of the program (Creswell, 2013). Some of the tutors described their responsibilities in the program as academic and non-academic support. In the survey responses, one of the tutors said: "I answer questions for the students during instruction. So if a student is having trouble grasping a concept, I make sure that they can understand the concept and keep up with the class." Another tutor describes how interactions can expand beyond the academic content:

> I have motivated students by letting them know that it is ok to make mistakes. I think this is important because it relieves a lot of anxiety that the students may have. I let them know that I also took the practice test, and I showed them where I made simple mistakes that anyone could have made. These actions also help students to remember mistakes that were made and know where to be cautious.

Similarly another tutor described her responsibilities as:

> Along with teaching the material, I have tried to work with students individually to help correct mathematical errors that they made. I have encouraged several students by building their self-esteem, I have counseled students as to what next steps they need to take (i.e. which math class to take in the future), and I have personally walked students to various places where they can receive help if it is not something that I can provide.

These examples signifies two different aspects of tutors roles and responsibilities in the program. They not only provide academic support by answering student questions and making sure they understand the mathematical concepts, but also they provide emotional and motivational support.

Similarly, another instructional staff said the following about the motivational support provided to the students:

> I motivated students primarily by describing my own difficulties in math and would tell them that if I can get a Bachelor's Degree in Math, then there is no reason why they shouldn't be able to excel in math as well.

Another tutor described her academic and emotional support for the participants as:

> I remind students that they are the most dedicated students at our school for coming to a math program that is outside of the regular semester. Although we correct mathematical errors that the student makes and we teach how to do the math properly, I always find something correct that the student is doing. I focus on what is good instead of focusing on what is wrong. I also reinforce that if they work hard for one week, they will be successful. Anyone can do anything for one week!

These examples described that not only the classroom tutors provided instant academic support for the students who had difficulties understanding the concepts, but they also provided emotional support by motivating, encouraging, and increasing students' confidence in their abilities to achieve success. This also aligns with what the former and current students explained about working with the tutors inside and outside classroom to receive academic and emotional support.

Furthermore, the majority of the instructional staff noted the significance of the multiple classroom tutors in students' success during the program. One of the instructional staff stated: "I think the changes that have been made over the past session

have been helpful (increasing classroom aides/tutor numbers and offering tutoring services).” Similarly, another staff stated: “I think the support provided for the students is entirely satisfactory . . . particularly with the second or third, additional tutors available during the lectures.” These instructional staff are referring to the increasing number of classroom tutors in order to cut down the wait time for the students to get their questions answered. One instructor explained that the additional classroom tutors provided support for the students who needed extra help during the lecture time and avoid slowing down the pace of the lecture as she noted:

> I appreciate that the number of tutors/aides in my class was increased to 2. They were able to answer more questions during the "lecture portion" and gave more attention to students that regularly request extra help. This helped to keep the pace of the class from slowing too much for the bulk of the students.

These survey responses confirm the effectiveness of the extra classroom tutors for providing academic and non-academic support for the students and the instructors. Likewise, from the interview data, the instructional staff voiced the importance of the extra classroom tutors to provide instant one-on-one assistance when needed. Terri who has been an instructor in the Mathematics Success program since 2014 explained her opinion about the extra classroom tutors as she said:

> Having the instructional aides and the tutors in the classroom where I can just say, “Hey, so and so… please help this person.” And they will spend time getting them to understand the concepts and then spend time catching them up to where I am. In the lecture… that’s probably the most helpful thing for me. If I have to answer all questions, I wouldn’t get through enough of the material for students to feel confident going into the placement test. I did notice that this was the first time that I had three instructional aides. And that was great because of those students that really needed that one-on-one. There were three tutors in class that I could ask to help students.

Here Terri describes that tutors in class helped her to answer any questions that students might have and helped them to catch up with the rest of the students. She mentioned that without extra tutors in classroom she might not be able to cover the entire contents that need to be taught.

Christina, who has worked as a tutor in classroom since the first session of the Mathematics Success program that was offered in summer 2014, described her opinion about the additional classroom tutors. She stated:

> Yeah! Summer 2014, that one was just a little rocky for the first couple of days when we were all figuring out where do we go, or what do we do, what's the setup, but now . . . I say it's really great and I really like having that extra person as an aide in there. I thought that was wonderful. Because if I'm dedicated to this one person who really needs that extra help, the other tutors are still there walking around while the instructor is doing her thing.

Christina mentioned that how much the program has grown and changed since the first session in summer 2014. She also noted that the additional tutors in class could focus on different students who need extra help during the lecture. Tina, who has worked as tutor and instructor since summer 2014, expressed her opinion on the additional classroom tutors as she said:

> I really like having two aides. I really thought that was a benefit. I really enjoyed that. Because usually there's probably two to three students that I've noticed in our sessions typically that asked for more help during class. And it takes time. It takes a lot of focus for me to kind of balance that and the class. But if we have more aides then they can go to those students specifically and can work with them on the side. I thought that was a real benefit.

Tina who started as a tutor in summer 2014 and now she is an instructor in the Mathematics Success program explained that the additional tutors helped her balance teaching the mathematical concepts and responding students' questions. This was also

mentioned by other instructors in the program such as Terri. Overall, all instructional staff found the additional classroom tutors beneficial, valuable, and helpful to students and instructors.

Tutoring services. One of the interventions in the Mathematics Success program session that was offered in January 2017 was offering tutoring services to the participants outside classroom from 8:00 a.m. to 5:00 p.m. every day. This was the only way students could receive extra assistance if needed since the Tutoring Center and the Math Learning Center were closed during the Mathematic Success program. All instructional staff identified the tutoring services as one of the most important and valuable aspects of the program that helped students succeed in the mathematics placement test. Tutors outside classroom provided opportunities for students to continue practicing and learning the mathematical contents under the supervision of tutors, and helping them one-on-one when needed. Sample written responses to the surveys are quoted below followed by excerpts from the interview transcripts.

From the survey data the majority of instructional staff described the tutoring services as one of the most beneficial aspects of the program in participants' success. One of the staff wrote:

> Having the additional tutoring is a significant help for many of the students. There are a small percentage of students whose basic skills are very poor and they may still have great difficulty in passing the placement test.

This instructional staff is referring to some of the students who have weak mathematical background or they may come back to school after many years, thus they need extra help to study and comprehend the mathematics concepts. Another staff noted:

"I like the tutoring support for the students. The tutoring that is available before and after class is great because it gives the students an opportunity to ask questions and get more detailed questions and individual attention."

Likewise, from the interview data, the instructional staff voiced the importance of the tutoring services for students who needed extra one-on-one assistance or they needed to practice daily homework and quizzes with the tutors. Terri who has worked as an instructor in the Mathematics Success program since 2014 said:

> . . . And then having the tutoring hours so that, if students still feel like they need a little extra help . . . It's great to have somewhere that they can go and feel comfortable to ask for extra help. Otherwise, they will be disappointed and may be discourage to come back the next day.

Terri highlighted the valuable support that the tutoring provided for the students who needed extra help otherwise they might get discouraged and leave the Mathematics Success program. In addition, since taking the mathematics placement test is a requirement for many of the students, they may get discouraged and leave the Oceanview Community College forever. Linda who has worked as a tutor in classroom for two years and worked as a tutor in tutoring room in the January session expressed:

> It helps to have the tutoring for students . . . Before and after class for those who need it . . . I think the people that you have teaching and guiding them are all . . . very interested and helpful to the students. And I think the students . . . feel . . . confident to ask them and feels important to ask them.

Linda explained that the tutors and instructors are willing to assist the students in any way possible and students has experienced and sensed this desire, thus they feel confident and comfortable to ask their questions without any hesitations.

Claire, one of the experienced instructional staff who has worked as a tutor and an instructor in the program explained that she encouraged students to take advantage of tutoring services in the program. She stated:

> …As I mentioned, I think the . . . extra tutoring support . . . is a really great feature. I do my best to kind of promote it, in the classroom a lot. Mentioning it before every review session and reminding them that if they feel . . . that they haven't got it down yet . . . or they're still a little lost . . . that they have the tutoring as an option . . . I don't know how . . . much it was utilized because I wasn't in there. But I think that's really good support for them.

Tina who has worked as a tutor in classroom as well as an instructor since the first session of the Mathematics Success program that was offered in summer 2014 described her opinion about the additional tutoring services. She stated:

> I think what we have . . . the changes to compare to when we started in 2014 and since then I'm really pleased with the changes . . . For example, the outside tutoring . . . I think that was something necessary. And when we didn't have it you could tell that some of the students needed extra time, extra explanation outside the class . . . and they didn't have that option. Now, they do, and I am very pleased with it.

Tina stated that the tutoring services was something needed for students who needed one-on-one tutoring so they can improve their mathematical skills. Before implementation of tutoring services, these students have no access to any extra help outside the program. All these examples provide affirmation that the tutoring services increased students' success in the program by providing extra one-on-one assistance, improving mathematical skills, boosting their confidence, and motivate students to achieve success.

Supplemental Practices. One of the interventions in the Mathematics Success program session that was offered in January 2017 was providing supplemental practices

such as daily homework and quizzes for the participants. This reinforced the learning and understanding of the concepts practiced for four hours with the instructors and tutors. Some students who desired to continue practicing to improve their mathematical skills found these supplemental practices very helpful in their success in the mathematics placement test. All fourteen instructional staff identified the daily supplemental practices that were handed out at the end of each class as one of the most important and valuable aspects of the program that helped students succeed in the mathematics placement test. Sample written responses to the surveys are quoted below followed by excerpts from the interview transcripts.

From the survey data some instructional staff noted the significance of the supplemental practices in learning mathematics and success in the program. One of the staff said: “The best support I have gotten in this Program was daily practice and quizzes already made. When I first started working for the program, I would make homework and quizzes and would email them to the students.” This instructional staff noticed the need for the daily extra practices so in earlier session, she created the practice worksheets for her students so they can practice the concepts at home.

Another survey participant said: “The homework and quizzes that were provided this time were great. Students want problems to work on over the weekend because they feel they need to practice every day. I believe this would be beneficial to everyone.”

This survey response expressed the need for supplemental practices from students. Some students requested daily homework from the instructional staff in the program. Thus, the daily extra homework and quizzed were added to the Mathematics

success program in order to address students' needs and to increase their success in the placement test.

Likewise, from the interview data, the instructional staff voiced the importance of the daily homework and quizzes for students who needed supplemental practices to reinforce their learning and improve their mathematical skills. Terri who has worked as an instructor in the Mathematics Success program since 2014 expressed her point of view on supplemental practices:

> I think the students really appreciate the daily problems and quizzes. At first I think they thought it was going to be a quiz that was graded . . . and once they realized that, "oh, it's just a self-check . . . " I think they were glad to have it. It's nice to have something to take home . . . And the first day . . . I actually, I had everybody come and put problems on the board . . . And later in the week the aides, during the second two hours, had the students . . . come and do the problems and put them on the board if they thought they could do it . . . So . . . they were getting extra practice.

Terri explained that not only the daily homework and quizzes practices helped students to assess what they learned and practiced in the classroom with their instructors, but also it provided an opportunity for a group work in the class as the students put the problems on the board and showed their work. Similarly, Christina who has been part of the Mathematics Success program since summer 2014 said:

> Before you provided the daily practices in the program, I made some problems and gave them to the students as a daily practice, both homework and the quiz. I didn't give them any answers or worked out solutions. I gave them homework first and then later on, throughout the day . . . I would email them all of the worked-out solutions to all of the problems. Not just the answers because I think . . . just giving them the answers if they get it wrong, would bring down their confidence. They might think they did the entire problem wrong when it could have been just a small little arithmetic error at the bottom. So now they're really beaten themselves up like I got this wrong. Like I should drop out now and I don't know anything. That part kind of bugged me because I was like, "NO! You're good all the way up to here . . . you just screw up this

> little tiny arithmetic step at the bottom." So it would be helpful to give them the practice sheet and the quiz first . . . and make them try it first, and then give them the solutions, but worked out not just the answers. I think that might be helpful.

Christina suggested providing the quizzes first and let students work on them on their own. Then later on the day, email students the step-by-step solutions so they can compare their answers and assess themselves. In January 2017, the participants received the daily homework and quizzes on separate sheets of paper and the final answers were included on the back of the paper so the students can check their work. Students had the opportunity to ask their questions the next day in class or go to tutoring services for extra help.

Similarly, Linda who has worked as a tutor inside and outside of the classroom said: "I like having the practice quizzes with the answers . . . and they came back with questions on those . . . the next day."

Tina, one of the most experienced instructional staff expressed her opinion about the supplemental practices as she said:

> That was helpful . . . That was helpful. The students really seemed to like them . . . they were just grabbing the sheets out of my hands . . . (laughing) . . . and I know that some of them used them when they were at tutoring . . . I don't know . . . there were a few of my students that I know went to tutoring . . . I know that I saw them working on it when I popped in and scout things out . . . I saw that they were working on some of the material from the quizzes. I think that was very helpful.

This is another affirmation that the students were motivated to receive the supplemental practices and practice them either on their own or with the help of tutors. Similarly, Claire expressed her opinion on the quizzes as she noted:

> . . . And then a quiz, so they can really assess if they're retaining the information. Because often and it's mentioned in the Math Anxiety

> workshop that final step of assessment is very important. When you think you know it, and all of a sudden, you try to do an assessment, and all of a sudden you realize . . . you don't know it. So, I think that kind of really underscores the process of learning . . . And it provides an opportunity for the students to really gauge for themselves . . . And also, start building really good habits. You know like after the class is over and they're at home, they have this one page piece of paper, for the practice, and it's up to them to find the time to really dedicate to that practice time and to their self-assessment. This time I started every review asking if anyone had questions on last night's work . . . Whether that was on the quiz or practice . . . So again, it kind of clears up any confusion or issues that any student had with those.

Claire highlighted that she started every session with giving students opportunities to ask their questions on the last night work. This would open the discussion about the difficulties students faced doing the supplemental practices and would give the instructor an opportunity to review the concepts that need more attention.

Shane, one the instructors who recently joined the Mathematics Success program said:

> It's a brilliant idea. The fact that you're giving them extra problems . . . I can see like 80% of the students in my class . . . they were so motivated about it. They loved it and they came and . . . they asked questions the next day . . . and my aides and I . . . we tried to go over those questions and it's very useful, but just the fact that they know someone is going to look at it, it's going to encourage them to do more.

Likewise Kim, one of the most experienced instructional staff who has worked for the program since summer 2014 said:

> The daily quiz and the practice . . . that's what people want. They want more practice . . . they crave for more. They always asked for more and . . . I think that was a really good idea. At first we didn't have the daily homework and quizzes . . . and I remember one of our colleagues, she was the one who thought of that. So we both worked together and made some worksheets and distributed them, but not every day. The students loved them . . . that was very beneficial to the students, so I'm glad that now the practice quizzes and homework are part of the program. It's really good.

Here Kim mentioned that she noticed the need for more supplemental practices, thus she and one of her colleagues, as proactive members of the program, started creating the daily extra practices for some specific lesson plans. Kim also mentioned the positive effect of the daily homework and quizzes on students' success in mathematics.

All these examples provided evidence of effectiveness of the supplemental practices such as daily quizzes and homework in student success in the Mathematics Success program. The instructional staff found these extra practices helpful in students understanding of mathematics concepts as they reinforced what they learned and practiced in the classroom.

Summary of Findings

In phase one, eleven former students of the Mathematics Success program were surveyed and interviewed. After thorough analysis of the surveys and interviews, four aspects of the program that were most helpful to increase participants' placement test were identified: *Classroom Tutors, Tutoring services, Supplemental practices, and the Math Anxiety Workshop*. Thus, the researcher implemented four interventions in the Mathematics Success program that was offered in January 2017. First, she added additional trained tutors to each classroom during the January session. All tutors attended a two-hour training offered by the researcher to enhance the tutors' skills and to increase the quality of tutoring offered in the program. Next, the researcher provided tutoring services for nine hours every day, 8:00 a.m. to 5:00 p.m. to provide one-on-one assistance for the students who needed extra help. Third, the researcher added the supplemental practices component such as daily homework and quizzes to the January 2017 session of

the Mathematics Success program. The daily homework and quizzes were provided to the students at the end of class each day. The final answer to the problems were also provided so the students could assess themselves. These were reinforcement-learning tools that the majority of the students found helpful in their understanding of mathematics concepts.

Finally, the researcher implemented a two-hour mandatory Math Anxiety workshop into the orientation session of the Mathematics Success program that was offered in January 2017. All participants attended the Math Anxiety workshop one day prior to the start of the program, and learned about learning process, tips on studying mathematics, study habits, anxiety reduce techniques, and test taking tips.

In phase two of this study, fifteen students who attended the program in January 2017 and all fourteen instructional staff were surveyed and interviewed. The survey responses and the interviews confirmed the effectiveness of the four interventions implemented by the researcher in the January session. All surveys responses and interview data from phase one and two of the study illuminated the effectiveness of the interventions in participants success in the mathematics placement test. All participants in the second phase of the study noted the additional classroom tutors, tutoring services, supplemental practices, and Math Anxiety workshop as beneficial, valuable, and effective in students' success in the program. The quantitative data confirmed this as well. Quantitative data showed significant difference in students' success in the program prior to the implementation of the intervention and post-interventions. The changes in the students' learning gains were not correlated to their genders, ethnicities, or the time since their last mathematics classes.

Chapter Five: Discussion

Overview of the Problem

Evidence of deficiencies among community college students in reading comprehension, writing skills, and mathematics competency has been documented nationwide (Callan, Finney, Kirst, Usdan, & Venezia, 2006; Sablan, 2014; Venezia & Jaeger, 2013). Nationally, between 40% and 60% of entering community college students are assessed into developmental mathematics courses (Goldrick-Rab, 2010; Li et al., 2012, Sablan, 2014). More specifically, 24% of these students are placed into one level below college-level, 16% to two levels below college-level, and 19% to three or more levels below college-level mathematics (Bailey, Jeong, & Cho, 2010).

In most colleges, entering students are assigned to different levels of developmental education on the basis of performance on placement tests. Placement exams are assessments that determine many students' college trajectories (Hughes & Scott-Clayton, 2011). Over half of entering community college students are placed into at least one developmental course, placement is based primarily on scores from these assessments (Hughes & Scott-Clayton, 2011; Scott-Clayton, Crosta & Belfield, 2014). Despite the large numbers of students entering developmental courses, recent research fails to find evidence that placement into remediation improves student outcomes (Hughes & Scott-Clayton, 2011; Scott-Clayton, Crosta & Belfield, 2014). In fact, research indicates that students placed into the lowest level of the developmental mathematics have a college-level mathematics completion rate in the single digits (Byrd & MacDonald, 2005; Kirst, 2008; Ngo & Melguizo, 2015; Prather & Bos, 2014). Thus,

gaining a deeper understanding of placement process and polices as well as placement test preparation programs is vital to the goal of increasing student success in college.

Over the last decade, some colleges have designed and implemented refresher programs to help students improve their placement scores. This includes posting warning statements in the college websites about the consequences of poor performance in the placement tests, and posting practice placement test questions without any guidance on how to solve the problems correctly. Some scholars and practitioners (need citation) have argued for activities designed to strengthen placement test orientation, increase student participation in pre-testing, offer appropriate post-testing interventions, incorporate placement test skill requirements into high school curriculum, and provide practice tests (Brown, 2006). These attempts at test preparation provide general information, but do not provide a targeted and condensed approach to break-down the content of the mathematics placement test.

At Oceanview Community College, where this study was conducted, about 77% of entering college students were placed into developmental mathematics courses; the majority of these students came from historically underserved populations. The data from this study reflects the national trends on developmental mathematics and college readiness, making it a representative site for inquiry.

At Oceanview Community College, the Mathematics Success program, a refresher developmental mathematics program, implemented in summer of 2014, was found to be a promising step for improving student achievement in mathematics. The Mathematic Success program provided a shorter path to college-level mathematics courses for entering students for the purpose of improving placement test scores.

Participants attended an intensive review program for four hours per day, for seven days, that included two hours of instruction and two hours of review with instructional staff. The curriculum for this program was designed based on the topics covered in the mathematics placement test. Students who successfully completed the program retook the mathematics placement test to improve their scores so that they could enroll in a higher-level mathematics class and reduce their time-to-degree. Throughout the three years that this program has been in practice, 95% of participating students placed into a higher-level mathematics class after attending the program and taking the mathematics placement test.

This study focused on the Mathematics Success program and implemented a design-based case study approach, which was used to describe and evaluate an intervention, or phenomenon, and the real-life context in which it occurred (Cobb, Jackson, & Dunlap, 2014; Baxter & Jack, 2008). At this time, the current research on placement tests preparation programs is inadequate to either inform the practitioner community or provide insight into designing an efficient and sustainable refresher program. Thus, the researcher chose a design-based case study for the purpose of informing practitioner-based community in a way that will allow for the design of an effective program. Specifically, the following questions were addressed in the study:

1. From students' point of view, what aspects of the program were most helpful in increasing their placement test level?
2. From students' point of view, what aspects of the program should be changed to make the program more effective?
3. From program instructional staff's point of view, what aspects of the program have the most impact on students' ability to increase their placement level?

4. From program instructional staff's point of view, what aspects of the program should be changed to make the program more effective?
5. Is there a change in placement test scores between pre-test scores (T1) and post-test scores (T2) after attending the program?
6. How much of the variance in the change in the students' scores on the placement test can be explained by gender, ethnicity, and previous mathematical skills?

This chapter offers a summary of findings from the study, notes connections of findings with empirical research and other literature cited previously in chapter 2, and provides additional literature that helps elucidate some of the study findings. Limitations of the study will be described, as well as implications for practice and policy in educational leadership and social justice. Suggestions are posed for future research related to these implications, and practical applications for increasing access to college-level mathematics courses.

Summary of Findings

Phase one of the Study. Overall, 40 individuals were surveyed and interviewed for this qualitative study. In phase one of the study, eleven former students who attended the Mathematics Success program prior to Jaunty 2017 were surveyed and interviewed. Four themes originated from these surveys and interviews, Including *classroom tutors, tutoring services, supplemental practices, and Math Anxiety workshop.*

Classroom Tutors. Ten out of eleven former students identified classroom tutors as the most effective, beneficial, and helpful aspect of the program, which also reflected the responses to the survey questions. Participants mentioned that classroom tutors

provided instant assistance if students did not understand a concept, walked students through the process, helped them one-on-one when it was needed, and assist them so they could continue with the rest of class. Additionally, the former students signified the need for more classroom tutors to assist more students, providing opportunities for students to ask more questions, and reducing the wait time. Thus, the researcher added additional tutors to the Mathematics Success program that was offered in January 2017.

Tutoring Services. Nine out of eleven former students identified tutoring services as the second most valuable and effective aspect of the Mathematics Success program, which also reflected the responses to the survey questions. Students needed tutoring hours outside the classroom so they could continue practicing and learning the mathematical contents under the supervision of tutors, spending more time outside classroom to practice and ask more questions, and get one-on-one help when needed. Furthermore, the former students signified the need for additional tutoring services to provide one-on-one assistance for students who need more supervised supplemental practice. Since the Mathematics Success program is offered during the time that the Math Learning Center is closed; the program participants have no access to any other tutoring outside the program. Therefore, the researcher increased the tutoring hours from two hours on the last day to 8:00 am to 5:00 pm every day in the Mathematics Success program that was offered in January 2017.

Supplemental Practices. Eight out of eleven former students identified the supplemental practices that sometimes were provided during the program valuable and effective, which also reflected the responses to the survey questions. Supplemental practices includes daily quizzes and homework as well as the extra practice test that

students take on the last day of the program before taking the mathematics placement test that helped in reducing their test anxiety and boosting their confidence. Students benefited from the supplemental practices so they can continue practicing the mathematical concepts discussed in the program after leaving the class. Also, the supplemental practices assisted the participants to assess themselves and their understanding of the mathematical concepts at home and on their own. In addition, the former students revealed the need for more practice problems on a regular basis as they reinforced what they learned and practiced in the classroom with the instructional staff. As a result, the researcher implemented daily quizzes and homework in the Mathematics Success program that was offered in January 2017.

Math Anxiety Workshop. Seven out of eleven former students identified the Math Anxiety Workshop as one of the useful and beneficial aspect of the program. Prior to January 2017, the participants had the option of attending a two-hour Math Anxiety workshop that was offered once during the program by a mathematics faculty and a counselor. Many former students who attended the workshop found it helpful to learn about study techniques and mindset techniques. Participants learned about study techniques such as how human brain learns and remembers, tips on studying mathematics, test taking tips, and study habits as well as mindset techniques such using available resources, anxiety reduction techniques, breathing techniques, and perseverance. The participants noted that not only did the workshop create additional support during the program, but also assisted them with future college-level mathematics courses after attending the program. Furthermore, students stated that all participants could benefit from the information shared in the Math Anxiety workshop regardless of

their mathematical knowledge and skills since they can apply it to any other courses that they take in the future. As a result, the researcher added the Math Anxiety workshop to the orientation session as a mandatory component of the program that was offered in January 2017.

Implementation of Interventions. After studying and analyzing the former student surveys and interviews, the researcher implemented four interventions in the Mathematics Success program that was offered in January 2017. First, she added at least one additional tutor to each classroom during the January session. Students benefited from two to three tutors available in the classroom every day during the program who attended a two-hour training offered by the researcher to enhance the tutors' skills.

Next, the researcher provided additional tutoring opportunities for students and increased the tutoring hours outside classroom to nine hours every day, 8:00 am to 5:00 pm, in the Mathematics Success program that was offered in January 2017. This was particularly beneficial to the students since during the time that the Mathematics Success program is offered the Math Learning Center is closed and the program participants have no access to tutoring outside the program.

Third, the researcher added the supplemental practices such as daily homework and quizzes to the January 2017 session of the Mathematics Success program. The daily homework and quizzes were provided by the researcher to the students. The hard copy of the daily supplemental practices were delivered to the instructional staff and were distributed to the students.

Finally, the researcher implemented a two-hour mandatory Math Anxiety workshop into the orientation session of the Mathematics Success program that was

offered in January 2017. All participants attended the Math Anxiety workshop one day prior to the start of the program, and benefited from topics such as the science behind learning and memory strategies, tips on studying mathematics, study habits, anxiety reducing techniques, and test taking tips.

Phase Two of the Study

Quantitative Results. To answer the last two research questions, the researcher conducted a series of quantitative analyses. As shown in Chapter 4, the results indicated that participants in the program performed significantly better in the mathematics placement test after the changes were implemented. This significant change implies that the interventions were effective and most helpful to the participants in January 2017 session. The results also showed that student success on the mathematics placement test was not related to their gender, ethnicity or the time since their last mathematics courses taken. This significant result showed that Mathematics Success program provided equal opportunities for students regardless of their gender, ethnicity, or mathematical background.

Qualitative Results. In phase two of the study, fifteen students who attended the Mathematics Success program in January 2017 and all fourteen instructional staff of the program were surveyed and interviewed. The majority of fifteen current students noted *classroom tutors, Math Anxiety workshop, tutoring services, and supplemental practices* as the most effective and valuable aspects of the program (in order of importance).

Classroom Tutors. The compilation of statements from participants of the survey and interview on January 2017 signified that providing additional tutors in the classroom was a successful intervention. All fifteen current students identified additional classroom

tutors as effective and helpful to provide opportunities for students to ask more questions and to reduce the wait time for asking questions. Students noted that the classroom tutors provided instant assistance to them if they did not understand a concept, walked students through the process, and helped them so they could continue with the rest of class. They also mentioned since there were two or three tutors available in class, there was no waiting time to get their questions answered.

Math Anxiety workshop. All the statements from survey and interview participants signified that the Math Anxiety workshop provided the participants many practical and valuable knowledge such as study skills and mindset techniques. Some study skills that were presented include the science behind learning, study habits, and understanding and applying mathematics formulas. Some mindset techniques that were presented include managing and reducing anxiety, breathing techniques, and information about student resources such as the Math Learning Center and Tutoring Center. All fifteen students noted that they applied these skills during the Mathematics Success program and furthermore they were able to apply this knowledge throughout their college coursework.

Tutoring Services. Twelve out of fifteen participants confirmed that the tutoring services provided support for the students who needed extra help to understand the concepts. It provided students more time to continue practicing mathematical concepts under the supervision of tutors, spend more time outside classroom to practice and ask more questions, and receive one-on-one help when needed. All of the participants who attended the Mathematics Success program in the January 2017 session had access to tutors from 8:00 a.m. to 5:00 p.m. every day. Additionally, many participants praised the

level of attention and caring they received from the tutors in the program. The majority of the students noted that the tutors outside the classroom had a deep understanding of mathematical concepts, homework and quiz problems, and if students missed a day they could meet with the tutors before or after class to catch up.

Supplemental Practices. Twelve out of fifteen students noted the effectiveness of the supplemental practices such as daily quizzes and homework and the practice test in student success in the Mathematics Success program. Students found these supplemental practices helpful in their understanding of mathematics concepts as they reinforced what they learned and practiced in the classroom. Furthermore, the multiple-choice supplemental practices helped the participants to assess their knowledge of the mathematical concepts at home and on their own. Also, the practice test given on the last day of the program helped them to assess their mathematical knowledge and reduce their test anxiety to ultimately boost their confidence.

Overall, all students found the Mathematics Success program valuable to their success in the mathematics placement test and showed great appreciation for the program. One of the students who attended the program in January expressed his opinion about the program in the survey response:

> This program is genius!!!! I had all the knowledge in my brain, but just needed a short but dense review with talented teachers and aides!!! This program should be copy written and sold to universities!!! I would have paid for it!!!!

Here the student noted the fact that he learned about these mathematical concepts before and he needed a refresher and intensive review to obtain success in the

mathematics placement test and be placed into a college-level mathematics. Another survey participants noted:

> Everything was AMAZING! I loved the support given from all teachers and teacher aids. It was a great idea to have tutoring for students outside of the classes.

Here the student show his satisfaction with the program, teachers and aides. Additionally, he appreciated access to the tutoring services. Overall, the majority of the study participants who attended the January session expressed their satisfaction with the interventions and found them valuable and beneficial in their success in the program.

Instructional staff. In phase two of data collection, the researcher surveyed and interviewed all fourteen instructional staff representing different genders and ethnicities. All instructional staff identified *classroom tutors, tutoring services, and the supplemental practices as most beneficial aspects of the Mathematics Success program* (in the order of importance.)

Classroom Tutors. All instructional staff found the additional classroom tutors beneficial, valuable, and helpful to students and instructors. Instructional staff believed that classroom tutors helped students academically and non-academically to succeed in the mathematics placement test. They not only provided academic support by answering student questions and making sure they understand the mathematical concepts, but also they provide emotional and motivational support to boost students' self-confidence.

Tutoring services. All instructional staff confirmed that the tutoring services increased students' success in the program by providing extra one-on-one assistance, improving mathematical skills, boosting their confidence, and motivating students to achieve success. All participants of the Mathematics Success program in January 2017

benefited from the tutoring services from 8:00 a.m. to 5:00 p.m. every day. This was the only way students could receive additional assistance if needed since the Tutoring Center and the Math Learning Center were closed during the Mathematic Success program.

Supplemental Practices. All fourteen instructional staff confirmed the effectiveness of the supplemental practices, such as daily quizzes and homework, in student success in the Mathematics Success program. They found these supplemental practices helpful in students understanding of mathematics concepts as they reinforced the learning and understanding of the concepts practiced for four hours with the instructors and tutors. Many students used the daily quizzes to assess their mathematical knowledge on a daily basis.

Limitations of the Study

There are some limitations to be considered throughout this design-based case study. First, former students and the instructional staff of the program who participated in the study may have been familiar with the researcher as they attend the program for seven days and may have had a student-teacher relationship. Also, some of the participants were former students of the researcher. Secondly, because there are little to no information regarding mathematics placement-test refresher programs, there is little comparative information. Finally, the DBR process is very similar to qualitative research, therefore, DBR inherits most of the strengths and weaknesses of qualitative research (Reimann, 2011). For example, we can observe the effectiveness of a certain design only in a specific situation, in specific classrooms with specific teachers, students, tools, resources, organizational culture, and situational factors (Reimann, 2011).

Positionality. There are positionality concerns that may affect this study. The researcher would like to acknowledge her position as the founder, designer, implementer, and the person in charge of the program, and how this may play into her data collection process. She has received a great deal of positive feedback from the students and staff about the Mathematics Success program. However, it was brought to her attention that this may be due to the fact that she is in charge of the program and it may be difficult for her students and staff to express their opinions unreservedly. While her position as the founder of the Mathematics Success program may influence data collection, her positionality also allows for a unique vantage point and access to resources that can strengthen this study. Her familiarity and experience with the program's design and curriculum is critical in this research. Furthermore, her position within the College as the chair of pre-transfer mathematics has been helpful in accessing faculty and students, and so, the researcher implemented measures to ensure that the process of collecting and analyzing data was done in the most accurate and unbiased way possible. Also, the researcher did not teach in the program in January 2017 session in order to eliminate any interaction with the students or instructional staff. All the interview questions were sent to the participants in the form of survey so they can answer the questions without the presence of the researcher. Also, participants were notified that there will be no negative consequences from any of the information that they reveal during the interviews. The researcher was mindful to lookout for any hesitation with students in honestly sharing feedback and was prepared to select a different interviewer if this occurred in data collection. The researcher did not sense any hesitation from research participants.

This method is informed by DBR and allows participants to be transparent and express their opinions freely (Bransford, Brown, & Cocking, 2000; Sawyer 2005). Furthermore, this type of research has been conducted by many stakeholders, like the founders and key decision makers, who are actively engaged in developing the evaluation and all phases of its implementation. This approach provides stakeholders with the opportunity to reflect on program progress and inform other community practitioners. It also provides opportunities for many people involved to take corrective action and make improvements. Finally, the researcher in the investigation is not just interested in findings, but in creating a learning process. It creates a knowledge base among local people and organizations, which can be applied to other programs and projects. The techniques and skills acquired can lead to self-sustained action (Zukoski & Luluquisen, 2002). The researcher positionality aligns with the open and interventionist nature of DBR, given her closeness to the research this study is well suited to reveal the inner-workings of the Mathematics Success Program rather than create generalizable results.

Implications of the Study

This study provided a design-based case study to understand the design, implementation, and outcomes of the Mathematics Success program at the Oceanview Community College. The interviews with the former and current students as well as instructional staff were eye-opening as the interviewees provided their insights to the different aspects of the program. They were enthusiastic individuals dedicated to learning and helping others to learn from their experiences and obstacles. Some of the interviewees shared their long experience of failure and disappointment with learning mathematics, and how it influenced their educational and career goals. Participants

embodied resilience and courage as they shared their failures and successes in their mathematical journey. The findings from this research imply broader implications. There are lessons within the surveys, interviews, and results that become concrete implications of the study applied to practice, policy, and point to future research opportunities.

Implications for Practice

Considering this study, there are considerable implications for higher education practitioners who desire to improve access to college-level mathematics courses for underrepresented students. This study provided insights to the design, implementation, improvement, and outcomes of the Mathematics Success program that may either inform the practitioner community or provide insight to design an efficient and sustainable mathematics refresher program. This study revealed that classroom tutors, tutoring services, supplemental practices, and Math Anxiety workshop are the most beneficial aspects of the Mathematics Success program that helped the participants succeed in the mathematics placement test.

Classroom tutors had a significant role in students' success in the Mathematics Success program. Practitioners who are interested in designing and implementing similar mathematics refresher programs need to realize that the number of tutors in classroom and the quality of work they provide are critical to participants' success in the program. Initially, the researcher assigned one classroom tutor to each class which has about 24 students, and almost all students asked for more tutors in classroom so they can receive instant help and feedback. In January 2017, the researcher increased the number of classroom tutors to three, and all students expressed their satisfaction about the available classroom tutors as it cut down the wait time for the participants. Additionally, the

researcher provided a two-hour training for all classroom tutors to enhance the tutors' skills and to increase the quality of tutoring offered in the program. The researcher discussed different topics during the mandatory training and reminded everyone about the student-centered approach in the Mathematics Success program. The researcher also presented how to explain different mathematics topics with a systematic step-by-step approach during the training. This was followed by a group discussion about the benefits of this technique. These techniques and sufficient resources for tutors are recommended for practitioners looking to increase the success of the mathematics program.

Tutoring services had a significant role in participants' success in the Mathematics Success program. The tutoring services provided extra support for the students who needed more time to continue practicing and extra help to understand the concepts. Thus, the researcher provided additional tutoring opportunities for students outside classroom every day, 8:00 am to 5:00 pm. This was particularly beneficial to the students since during the time that the Mathematics Success program is offered the Math Learning Center is closed and the program participants have no access to tutoring outside the program. The interested practitioner should be aware that some students may require one-on-one help outside classroom to comprehend the mathematical concepts. Therefore, they need to provide opportunities for the participants to meet with tutors outside classroom in order to continue practicing the concepts. The number of hours and the specific time the tutoring services are offered should satisfy students' need, as they are important in the participants' success in the program.

This study revealed that supplemental practices such as daily quizzes, homework, and extra practice test had a vital role in participants' success in the Mathematics Success program.

Students utilized the supplemental practices to reinforce the mathematical concepts discussed in the program, and as an assessment tool of their mathematical knowledge. Practitioners who are designing similar programs should incorporate different forms of supplemental practices so their students are able to reinforce daily practiced concepts. Each of these supplemental practices could include 15 to 20 problems that students practiced in class to promote further learning. In addition, the researcher suggests including the answer key to students can assess their work. By integrating regular opportunities to practice the concepts taught in the program, practitioners have the opportunity to reinforce mathematical concepts and establish a level of familiarity through repetition. Practitioners should include a wealth of supplemental practice problems as students will have varied needs and providing these materials is an efficient and cost effective means of implementing sufficient assessment throughout the program.

The study findings indicated that the Math Anxiety Workshop contributed significantly to students' success in the Mathematics Success program. The two-hour Math Anxiety workshop, which was offered by a mathematics faculty member and a counselor, provided the participants practical knowledge such as study skills and mindset techniques. Interested practitioners should acknowledge that math anxiety is a major barrier for many students, therefore there is a great benefit to incorporating a similar informational workshop to teach anxiety reducing techniques and engage in specific techniques like breathing exercises. The workshop can address the prevalence of math

anxiety and present strategies to combat this barrier. Furthermore, practitioners should teach the participants some study skills, the science behind learning, and study habits. Additionally, all participants can benefit from information regarding their respective student resources, in this study on campus resources included Math Learning Center and Tutoring Center.

Another recommendation for practitioners embarking on creating comparable programs is to engage in cross-disciplinary collaborations, particularly with the Testing Office. This is necessary in order to align program goals and objectives with the Testing office's policies and requirements. For example, the researcher worked very closely with the director of the Testing office at the Oceanview Community College to learn about their policies and regulations. Furthermore, in order to design and create the curriculum of the Mathematics Success program, the researcher worked with the director of the Testing Center to learn about the different mathematical topics covered at different levels of the mathematics placement test. Next, the researcher worked with different mathematics faculty at Oceanview Community College to design the most appropriate curriculum that not only prepares the participants for the mathematics placements test, but also assist them to be successful in college-level mathematics courses. This collaboration and partnership continued to design and improve the program's curriculum to best serve the student population.

Next, the researcher worked with the office of instruction on the logistics of offering the Mathematics Success program. She faced many obstacles such as lack of space, lack of interested faculty and staff to work on a new initiative, and limited budget. In order to have access to appropriate classrooms, the researcher offered the program

after each semester was completing. Also, in summer 2014 when the program launched, she was the only faculty teaching in the program, however after program achieved a high success rate, many full-time and part-time faculty began to teach in the program as well. The researcher also worked with the Human resources office to create job positions, job responsibilities, and a pay table for the instructional staff. Initially the program was funded through the Basic Skills Initiatives with limited resources and after the program showed great success, it was funded through Student Success and Support Program (SSSP) with greater budget and resources. This helped to improve and expand the program by hiring more faculty and instructional staff and providing training and professional development to enhance the quality of the program.

Furthermore, the researcher worked with the director of Outreach program at Oceanview Community College to recruit students from local high schools. This process included visiting various local high schools as well as hosting different meetings for high school students and their counselors to inform them about the Mathematics Success program. Program flyers were distributed to different local high schools and were posted on different campus locations. As the program expanded, an assistant was hired to manage students' enrollment, high school outreach, and program advertisement. Currently, the program serves about 200 to 250 students per year.

Implications for Policy

College assessment and placement policies have a great impact on students' first semester courses (Houser, & An, 2014; Li et al.,2012; Prather & Bos, 2014). Many colleges have implemented Multiple Measures Assessment that utilizes more than one indicator of college readiness to place entering students into college-level coursework.

The Multiple Measures Assessment are a combination of high school grade point average (GPA) and standardized placement tests (Dadgar, Collins, & Schaefer, 2015; Scott-Clayton, Crosta & Belfield, 2014). Colleges that still utilize placement tests to assess and place entering college students could design a similar refresher program to prepare the entering students for the placement tests. This could be extremely beneficial to many students as the many researcher indicate that students who are placed in the lowest level of the developmental mathematics have a college-level mathematics completion rate in the single digits (Byrd & MacDonald, 2005; Kirst, 2008; Ngo & Melguizo, 2015; Prather & Bos, 2014). The research also shows that in two large community college systems nearly a quarter to a third of the students may have been misplaced into developmental courses when they could have succeeded in a college-level courses (Scott-Clayton et al., 2014). Thus, offering a refresher program such as the Mathematics Success program may assist many students brush up their mathematical knowledge, achieve success in the mathematics placement test, be placed in a higher-level mathematics course, and save time and money.

Significance of the Study

The college readiness of high school students is a high priority across the U.S. education system. Many national and state policies, initiatives, and reforms are focused on better preparing students for college-level courses (Hodara & Cox, 2016). With over three million new students entering college each year, the national cost of remediation programs are nearly $7 billion dollars annually (Scott-Clayton, 2014). While the lack of college readiness among entering college students has generated extensive concern in

higher education, little attention has been paid to how college readiness is actually determined (Scott-Clayton, 2014).

Many colleges place students in developmental or college-level courses based on scores on short standardized mathematics and English placement tests. Colleges mostly place students in developmental courses based on performance on the SAT or ACT, or the ACCUPLACER or ACT Compass (Fields & Parsad, 2012). Recent research suggests that placing students to developmental or college-level courses based on standardized placement exams results in large numbers of placement errors, and that incorporating high school transcript information would lead to fewer assignments to remediation while maintaining or increasing success rates in college-level Math and English (Scott-Clayton, 2014; Scott-Clayton, Crosta, & Belfield, 2014).

To apply a more comprehensive approach to placement processes, many colleges are beginning to use Multiple Measures Assessment which uses high school grades or high school grade point average in addition to test scores (Bracco et al., 2014; Dadgar, Collins, & Schaefer, 2015; Scott-Clayton, Crosta & Belfield, 2014). Research on placement policies indicate that high school grade point average is a more accurate indicator for placing entering college students since it is not just a measure of cognitive ability. It is a cumulative measure of academic achievement in multiple subjects across a student's high school career (Dadgar, Collins, & Schaefer, 2015; Scott-Clayton, Crosta & Belfield, 2014).

Nationally, the use of Multiple Measures Assessment for placement has been proposed, and in some cases already implemented. For example, California currently has state-level implementation of Multiple Measures Assessment, prompted by the 1991

settlement of a civil rights lawsuit filed by the Mexican American Legal Defense and Educational Fund. The lawsuit argued that using only a single standardized assessment for placement disserves students from diverse racial groups (Bracco et al., 2014). Therefore, California community colleges use more than a single test score for placement. Some other colleges considered using additional measures only when students challenge their placement test results (Venezia, Bracco, & Nodine, 2010). Preliminary results from an evaluation of two community colleges in Los Angeles found that use of Multiple Measures Assessment had increased access to college-level courses without compromising student success rate (Ngo et al., 2013).

Oceanview Community College Mathematics Department agreed to use the Multiple Measures Assessment (MMA) for assessing entering college students in February 2016. After implementing the MMA, more entering college students were placed into the college-level mathematics courses. However, according to Oceanview Community College's research office, about 30% of the entering college students do not meet the requirements including the required high school GPA or the mathematics classes from high school will be placed into developmental courses. These students may choose to attend the Mathematics Success program to get adequate preparation for taking the mathematics placement test and potentially be placed in a higher-level mathematics course. Consequently, since these students do not have the required GPA or did not take the required mathematics class in high school, they may have lower mathematical skills and need more practice to understand the mathematical concepts. Thus, this may affect the Mathematics Success program's design to address the new populations' needs.

Social Justice Implications

Lack of college readiness of underrepresented students is an important social justice issue for educational leaders. Community colleges enroll about 44% of high school graduates (Callan, Finney, Kirst, Usdan, & Venezia, 2006). However, nationwide, only one third of college students achieve their educational goals within six years (Goldrick-Rab, 2010; Li et al., 2012). The results of several studies reveal that 40% to 60% of the nation's entering college students, who are first generation, low-income, and students of color, place in at least one remedial course in mathematics or English (Byrd & MacDonald, 2005; Goldrick-Rab, 2010; Li et al., 2012; Venezia & Jaeger, 2013). The need for mathematics remediation is extremely high among low income, African-American, and Hispanic students. Female students are also less likely to be ready for college-level mathematics coursework (Combs et al., 2016; Ganley & Vasilyeva, 2011; Garriott et al., 2014; Houser & An, 2014; Lee, 2012; Long, Iatarola, & Conger, 2009; Nord et al., 2011). Moreover, despite the fact that high school education plays a significant role in creating an even field for underrepresented students to be ready for college-level mathematics courses, numerous studies show that socioeconomically disadvantaged students have unequal access to higher level mathematics courses (Aughinbaugh, 2012; Kowski, 2013; Maxwell et al., 2003).

Some of the research studies examined in this study demonstrate how mathematics refresher programs have social justice implications by improving mathematics placement test outcomes for underrepresented students. Scholars have offered many suggestions to make strides towards a more equitable college education. Because of the existing research in educational field, leaders have begun to implement

interventions to provide more access to college-level mathematics courses for all students. These interventions have brought attention to the underprepared marginalized college students who continue to face obstacles as compared to White students from affluent backgrounds.

Implications for Research

This study utilized the design-based case study with two phases of data collection. This two-phase process enabled the researcher to make changes to the program that are in line with the design-based case study approach (Cobb, Jackson & Dunlap, 2014). The two-phase process was extremely valuable in this study as it allowed the researcher to collect data from the former participants of the program in phase one, and analyze that data and have a foundational understanding of specific implementable changes to improve the Mathematics Success program. After the first phase of this data collection, the second phase took place after research-based improvements were administered in the program. The second set of data was able to reveal the effectiveness of program improvements. Oftentimes data sets are collected at one time, however, this study presents an innovated and multifaceted approach to data collection.

Beyond presenting a two-phased approach this study also impacts researchers and opens the door for future efforts in the field. Given the range of major efforts in place in high schools and colleges to help marginalized students become ready for college coursework, it is difficult to isolate specific strategies that are more effective. However, looking across the spectrum of efforts, there is a gap in understanding the impact of intervention programs regarding mathematics assessment and placement in marginalized

students' success at community college-level. Future research is needed to understand the impact of mathematics assessment and placement policies on entering college students' success (Houser, & An, 2014; Li et al., 2012; Prather & Bos, 2014). Only a few studies in the literature have focused on the current assessment and placement policies for remedial mathematics courses, but further investigation is needed. The results of future studies on impact of mathematics placement intervention programs can assist entering college students, specifically, low income, African-American, and Hispanic students, to take a shorter path to college-level mathematics courses. Moreover, additional research has the potential to highlight deficiencies of mathematics assessment and placement policies and impact the practices of higher education professionals.

Recently, many higher education institutions have implemented the Multiple Measures Assessment (MMA), which uses a combination of high school grade point average (GPA) and standardized placement tests (Dadgar, Collins, & Schaefer, 2015; Scott-Clayton, Crosta & Belfield, 2014). Even though after implementation of the MMA, more entering college students were placed into the college-level mathematics courses, some students who do not meet the requirements including the required high school GPA or the mathematics classes from high school are placed into developmental courses. These students may choose to attend some refresher programs such as the Mathematics Success program to get adequate preparation for taking the mathematics placement test and potentially be placed in a higher level mathematics course. Consequently, since these students do not have the required GPA or did not take the required mathematics class in high school, they may have lower mathematical skills and need more practice to

understand the mathematical concepts. Thus, this may affect the Mathematics Success program's design to address the new populations' needs.

Whereas this study analyzed the Mathematics Success program generally, further research can explore individual development and growth of participants within the Mathematics Success program. Researchers can benefit from a deeper understanding of individual mathematical reasoning. Such a study would be a shift from a case study of the program to an investigation of individuals.

Conclusion of the Study

This design-based case study provided insights to the Mathematics Success program and its design, implementation, improvement, and outcomes. It included interviews of 40 individuals who were involved in the Mathematics Success program as the former students, current students, and program instructional staff to determine the most valuable aspects of the program on the students' ability to improve their mathematical placement level. Furthermore, statistical analyses were conducted to show the relation between the time since the last mathematics class and students' scores on the post-assessment, relationship between the post-assessment scores and pre-assessment results, and correlation among the ethnicity, gender and the post-assessment scores.

Study findings confirmed that classroom tutors, tutoring services, supplemental practices, and the Math Anxiety workshop were the most valuable aspects of the program to help students succeed in the mathematics placement test after attending the Mathematics Success program. Representative thoughts and opinions of the surveys and interviews responses were provided in chapter 4. In addition to addressing the research

questions, the themes offer insights to inform the practitioner community to design an efficient and sustainable refresher program in order to improve mathematics placement scores of the entering college students.

Many higher educational researchers believe that too few students advance from traditional remedial mathematics courses to college-level mathematics courses, which increases the pressure on community colleges to identify and scale-up successful developmental education initiatives. This study offers evidence of the effectiveness of one mathematics refresher program designed to help entering college students advance to higher level mathematics courses by improving their mathematics placement test scores. Based on this case study, the Mathematics Success program was effective in preparing the participants for taking the mathematics placement test. The overall success rate for the Mathematics Success program in January 2017, after implementation of four changes based on this study, was 97%, which is a significant achievement and shows that the programs accomplished much of its projected goals.

The qualitative results of this study indicated that after thorough analysis of the surveys and interviews of 40 students and instructional staff, the most helpful aspects of the Mathematics Success program in increasing students' placement test level were classroom tutors, tutoring services, supplemental practices, and Math Anxiety workshop. Furthermore, the results of surveys and interviews indicated that students and instructional staff identified additional classroom tutors, mandatory attendance in Math Anxiety workshop, tutoring services, and supplemental practices as the components that could make the program more effective.

This study contributes to the literature by expanding on previous research, indicating that offering short refresher programs for the entering college students to prepare them for the placement test influence their course placement and academic performance. In alignment with the iterative nature of DBR, the researcher will examine the Mathematics Success program in the future to ensure that program continues to meet the needs of its constituents and that the interventions are not stagnant measures. This research aims to build upon the growing design-based literature, while presenting evidence to spark a larger conversation regarding effective assessment practices in California community colleges.

Appendix A: Email Invitation to Participate (Former Students)

Dear Student,

I am a graduate student in the joint doctoral program at California State University San Marcos (CSUSM) and University of California, San Diego (UCSD). Also, I am the coordinator of the Bridge to Success in Math program at MiraCosta College. I am conducting a study that seeks to explore the Bridge to Success in Math program at MiraCosta College and find out about the different aspects of the program that have the most impact on students' success. You are being contacted because you were identified as a former student of this program within the last two years.

If you agree to participate in this study, I will send a link to an online survey via e-mail. Your responses to the survey questions will be anonymous. You will have two weeks to complete the survey. Three weeks after you complete the survey, I will email you to schedule an interview. The interview will be scheduled at a time that is convenient for you and will last approximately 40 to 60 minutes. The interviews will be audio-recorded and transcribed. Your responses to interview questions will be confidential. Your responses will not be linked to your name. Pseudonyms will be used in reporting of the findings. Lastly, I will ask your permission to review your pre and post placement test scores.

I am attaching the consent form for your review. If you are interested in participating in this study, please sign and return the consent form to me via email in two weeks.

Please let me know if you have any questions or concerns.

Respectfully,
Leila Safaralian
760-522-9832
lsafaralian@miracosta.edu

Appendix B: Email Invitation to Participate (Current Students)

Dear Student,

I am a graduate student in the joint doctoral program at California State University San Marcos (CSUSM) and University of California, San Diego (UCSD). Also, I am the coordinator of the Bridge to Success in Math program at MiraCosta College. I am conducting a study that seeks to explore the Bridge to Success in Math program at MiraCosta College and find out about the different aspects of the program that have the most impact on students' success. You are being contacted because you are currently a student in this program.

If you agree to participate in this study, I will send a link to an online survey via e-mail. Your responses to the survey questions will be anonymous. You will have two weeks to complete the survey. Three weeks after you complete the survey, I will email you to schedule an interview. The interview will be scheduled at a time that is convenient for you and will last approximately 40 to 60 minutes. The interview will be audio-recorded and transcribed. Your responses to interview questions will be confidential. Your responses will not be linked to your name. Pseudonyms will be used in reporting of the findings. Lastly, I will ask your permission to review your pre and post placement test scores.

I am attaching the consent form for your review. If you are interested in participating in this study, please sign and return the consent form to me via email in two weeks.

Please let me know if you have any questions or concerns.

Respectfully,
Leila Safaralian
760-522-9832
lsafaralian@miracosta.edu

Appendix C: Email Invitation to Participate (Instructional Staff)

Dear Instructional staff,

I am a graduate student in the joint doctoral program at California State University San Marcos (CSUSM) and University of California, San Diego (UCSD). Also, I am the coordinator of the Bridge to Success in Math program at MiraCosta College. I am conducting a study that seeks to explore the Bridge to Success in Math program at MiraCosta College and find out about the different aspects of the program that have the most impact on students' success. You are being contacted because you were identified as an instructional staff of this program.

If you agree to participate in this study, I will send a link to an online survey via e-mail. Your responses to the survey questions will be anonymous. You will have two weeks to complete the survey. Three weeks after you complete the survey, I will email you to schedule an interview. The interview will be scheduled at a time that is convenient for you and will last approximately 40 to 60 minutes. The interviews will be audio-recorded and transcribed. Your responses to interview questions will be confidential. Your responses will not be linked to your name. Pseudonyms will be used in reporting of the findings.

I am attaching the consent form for your review. If you are interested in participating in this study, please sign and return the consent form to me via email in two weeks.

Please let me know if you have any questions or concerns.

Respectfully,

Leila Safaralian
760-522-9832
lsafaralian@miracosta.edu

Appendix D: Interview Protocols for the Former and Current Students

1. When did you attend the Bridge to Success in Mathematics program? What level (Math 20, 30, or 64)?
2. How did you hear about the Bridge to Success in Mathematics program?
3. What do you think about the length of the program?

   Follow up questions: How would you react if I said that the program will be longer next year?
4. Please describe a time when the available support helped you succeed in the program.

   Follow up: [Depending on their comments] Can you explain how [whatever the interviewees said as support] was helpful?
5. What additional support would have made the program more helpful or effective?

   Follow up: How does [what they suggested] would help the program?
6. Please describe the elements that helped you succeed in college-level math courses after completing the program.
7. Please describe an experience in college-level math that for you, links to your experience in Bridge to Success in Mathematics program?
8. If the program were to be redesigned to support more students effectively, what part should be redesigned?

Do you have any additional comments or suggestions?

Appendix E: Interview Protocols for the Instructional Staff

1. How many sessions of the Bridge to Success in Mathematics program have you worked for?
2. What roles did you have?
3. Please describe some of your responsibilities in the Bridge to Success in Mathematics program.
4. Please describe a specific example of the support you provided the instructor. What was significant about that experience?
5. Please describe a specific example of how you motivated students in the Bridge to Success in Mathematics program.
6. Please share some examples of your interactions with the students after the completion of the program.
7. what do you think about the length of the program?
8. Please describe your opinion about the available support for the students in the program.
9. What other types of support would have made the program more helpful or effective for the students?
10. Please describe particular support that worked well for you as an aide in the program.
11. What additional support for the aides would have been beneficial?

Appendix F: Survey Questions for the Former and Current Students

1. When did you attend the Mathematics Success program? Drop down menu: summer 2014, December 2014, April 2015, Summer 2015, January 2016, Summer 2016, January 2017, other (if other, please explain.)

2. How did you hear about the Mathematics Success program? Drop down menu: Friends, counselors/advisors, testing center, my professor, Mathematics Success program fliers, others

3. What is your ethnicity? Drop down menu: White, Hispanic, Black, Asian, Filipino, American Indian/Alaskan Native, Black/ Not of Hispanic Origin, Pacific Islander, White/Not of Hispanic Origin, other, decline to state

4. In regard to gender, how do you identify yourself? Female, Male, other

5. What do you think about the length of the program? Drop down menu: the length of the program was just right, the length of the program was too short, the length of the program was too long, other (if other, please explain.)

6. If you felt the program helped you succeed in the area of math, what specifically was helpful? If more than one thing was helpful, please indicate more than one.

7. What other types of support would have made the program more helpful or effective?

8. If the program was effective, what specifically helped you succeed in college-level math courses after completing the program?

9. Please describe an experience in college-level math that for you, links to your experience in the Mathematics Success program?

If the program were to be redesigned to support more students effectively, what part should be redesigned?

Appendix G: Survey Questions for the Instructional Staff

1. How many sessions of the Bridge to Success in Mathematics program have you worked for? Drop down menu: One session, two sessions, three sessions, four sessions, five sessions, six sessions

2. What roles did you have? Drop down menu: I taught the class for two hours, I facilitated the review sessions, I taught the class and facilitated the review sessions, I was a tutor, other (if other, please explain.)

3. What is your ethnicity? Drop down menu: White, Hispanic, Black, Asian, Filipino, American Indian/Alaskan Native, Black/ Not of Hispanic Origin, Pacific Islander, White/Not of Hispanic Origin, other, decline to state

4. In regard to gender, how do you identify yourself? Female, Male, other

5. Please describe some of your responsibilities in the Bridge to Success in Mathematics program.

6. Please describe a specific example of the support you provided the students.

7. Please describe a specific example of how you motivated students in the Bride to Success in Mathematics program.

8. Please share some examples of your interactions with the students after the completing the program.

9. What do you think about length of the program? Drop down menu: the length of the program was just right, the length of the program was too short, the length of the program was too long, other (if other, please explain.)

10. Please describe your opinion about the available support for the students in the program.

11. What additional support for the students in the program would have been beneficial?

12. Please describe particular support that worked well for you as an instructional staff in the program.

What additional support for the instructional staff would have been beneficial?

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